MODERN PLASTICS

E. F. LOUGEE, Editor • DR. G. M. KLINE, Technical Editor • C. A. BRESKIN, Publisher

MAY 1940

VOLUME 17 NUMBER 9

• GENERAL INTEREST

Plywood joins the marines 27
Traditional transition 30
Making croquet tough 34
Announcing Fifth Annual Modern Plastics Competition 35
Student design 37
S. P. I. at Hot Springs 38
South American trade in organic plastics 42
A letter from London 46

• TECHNICAL SECTION

Permanence of the physical properties of plastics 49
Plastics at the A. C. S. meeting 53
Properties and performance of plastic bearing materials 54
Plastics digest 58
U. S. plastics patents 60

• NEWS AND FEATURES

Plastics in review 40
Stock molds 47
Publications 62
Equipment 64
They say— 66

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JUNE

At the Agricultural By-products Laboratory, Ames, Iowa, scientists of the Bureau of Agricultural Chemistry and Engineering of the U. S. D. A., seek new industrial uses for substantial quantities of such farm wastes as straw, cornstalks, corncobs and sugarcane bagasse. The Department research indicates that bagasse is a good potential source of inexpensive molding powder. A report entitled "Aniline-bagasse plastics," by T. R. McElhinney and S. I. Aronovsky, which deals with such research and experiments in developing a molding compound suitable for commercial use, will appear in our June Technical Section. Another in the series of articles on coatings, "Synthetic resins in corrosion-resistant paints," by R. G. Moore and the concluding part of J. Delmonte's report on "Permanence of the physical properties of plastics" will be included in this issue.

ADVERTISING PAGES REMOVED

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● Among the many Translucent INSUROK outdoor illuminated installations three are illustrated on this page. At the top a store front of Putman's in Cincinnati; the train end display of a Nickel Plate Limited; a laundry sign in Chicago. Its physical characteristics, strength and workability, and resistance to the elements make Translucent INSUROK highly useful in numerous ways for display work. Get acquainted with this amazing new plastic. See how easily unusual effects can be accomplished, and how quickly extra attention value is added by the use of INSUROK. Available in many pastel shades and deep, rich colors, in sheets of various gauges, up to approximately 15 square feet in area. Prompt delivery assured.

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MODERN PLASTICS

MAY 1940 VOLUME 17 NUMBER 9

Out of the blue—graceful sailboats skim along on waterproof phenolic resin-bonded plywood hulls. This trim sloop was designed by Henry M. Devereux

Plywood joins the marines

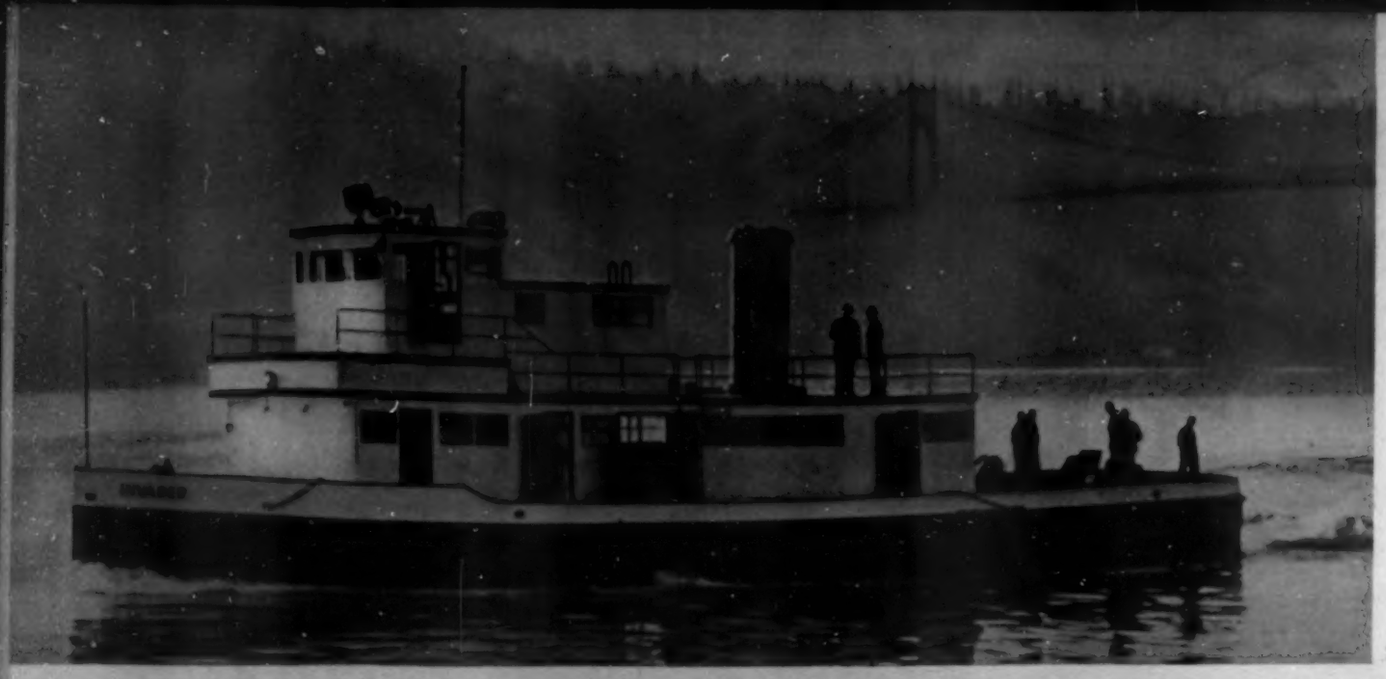
by C. R. SIMMONS*

Salt air, dampness or fog have little influence on resin-bonded wood

"WHY don't you have your next boat built of plywood?" is a question that would draw frowns of scorn from 50 percent or perhaps 75 percent of the boat owners of today and to many would quickly put the inquirer in the category of a befogged landlubber. But the odd part of it is that it's a question worthy of emanating from the *seagonin'est* owner in existence. For years plywood has been considered as one type of wood which should be kept from contact with excessive moisture or water because it would warp, crack, peel, buckle, separate. Today there is a plywood which does none of these things—phenolic resin-bonded plywood. In fact, in three short years this new plywood has waded right into boat builders' waters and is well on its way to give the older boat construction lumber a real swim for its money—whether for building kayaks or yachts—perhaps someday even for huge ocean liners.

Just how this new plywood obtained a foothold in

* Durez Plastics & Chemicals Inc.



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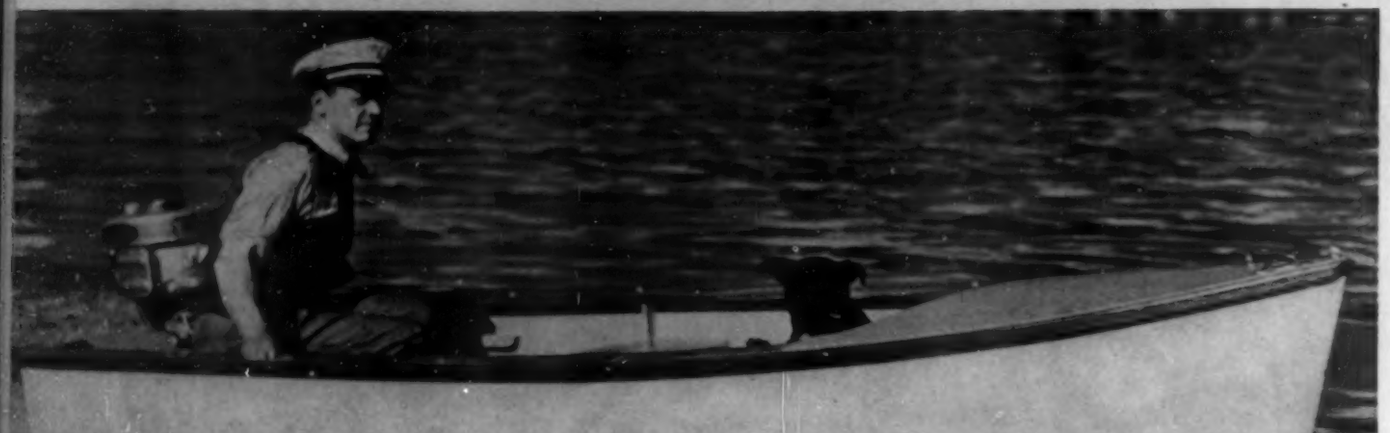


3

PHOTOS, COURTESY M & M WOOD WORKING CO.

With the greatest of ease the Invader **2** *tugs heavy oil and wheat barges up the Columbia River. Its superstructure, of* 3/8 *in. Resnprest (Durez resin-bonded) exterior plywood, is rugged, weather-resistant and saves considerable weight, allowing it to penetrate farther up the swift waters. Sturdy one-piece sides and bottom of the speedy Dillabaugh Sportsman runabout* **3** *are formed of the same material*

the boat industry is an interesting story covering several years. Among the first to test the new plywood was the well-known Herreshoff Mfg. Co. About six or seven years ago this company made exhaustive tests to determine the practicability of plywood.

They took unpainted pieces and immersed them in the steam and hot water compartments of their glue pot for two weeks where they alternately boiled, steamed, and cooled off as the water level rose and fell, at nights and over week ends. After that the same pieces were suspended from the sunny side of the Herreshoff dock so that they were in and out of salt water with each rise and fall of the tide. Then they were put back in the glue pot water compartment for a few days. After that they were frozen in a refrigerator for a couple of weeks and finally subjected to a very dry heat by being placed between the sections of a steam radiator.

Herreshoff still have those original test panels. You can examine them today and this is what you'll find. The bond between the plies is just as strong and tight as it ever was. The surface of the wood is not checked or distorted in any way. The only visible result of the rough treatment is a bleaching and aging of the color of the wood.

This company made up some experimental skiffs of the new plywood and put them over the hurdles, too. They left the skiffs in the water, absolutely unprotected, to watch the effects of a New England coastal winter and summer; of snow, ice, rain, sun,

and battering of heavy seas. Those boats stood up beautifully and at the end of a year even the old-timers who said they couldn't possibly stand up were convinced that there was to be a real place for phenolic resin-bonded plywood in their business. Herreshoff made another test that further proved this wood's mettle. They took a standard riveted oak mast hoop and one made from this new plywood and varnished them. Then they were subjected to the hot water, steam, cooling, sun and salt water tests used on the original panels. The results are clearly indicated in Fig. 10 (page 74).

Even in the face of these fine results the new phenolic resin-bonded plywood was not adopted on a grand scale for production. Instead, it was first used in watertight bulkheads of Herreshoff's $12^1/_2$ footers. Eventually it was used for decking, for seat brackets, and mast hoops.

In 1937 and 1938 many other well-known manufacturers began using the new plywood. The Cape Cod Shipbuilding Co. used it for decking and planking of their 10-ft dinghy. Nevins, Consolidated, M. M. Davis, Wheeler, Owens began to use it for interior paneling, bulkheads, doors, partitions. Lawley-Mumford Co. are prominent users, having developed an 8-ft. rowing and sailing pram in 1937 which incorporated radically new construction features. This unit was planked with $^3/_8$ in. fir plywood, resin-bonded. Light aluminum alloy castings were used in place of the usual knees, frames, stem and other structural members. The entire weight of (*Please turn to page 74*)

***Resin-bonded plywood has simplified boat building. Pictured here are several stages in the construction of a modern sloop. Looking toward the bow* 4 *we note plywood panels forming starboard topsides. From under the stern, port side* 5, *we see the method of fitting panels to chine timber. Viewed from the bow* 6, *is starboard side complete, and* 7, *the finished topsides, bottom and stern. The entire hull* 8, *sanded and covered with a prime coat—and there isn't a seam or joint visible, as in a planked hull! The deck too, nearly complete* 9, *is plywood. And she's shown afloat in Fig.* 1

1

Enter the Grosfeld House Glassic living room! At one end of the room **1** *is a console table resting upon a sturdy plastic pedestal, ornamented with a plastic apron of Greek design. Above it hangs a cabinet supported by plastic columns and decorated with plastic plumed finials. All the furniture in this and the other Glassic rooms is made entirely or in part of Plexiglas, a crystal-clear methyl methacrylate plastic made by Röhm & Haas*

2

At the opposite end of the room **2** *stands a tall breakfront of Empire design. Mirrored plastic pilasters and grill rods give a Twentieth Century touch to this familiar period piece. The same transparent plastic is used in the construction of easy chairs, side chairs, end tables and lamps in this modern living room*

3

The long, low, comfortable divan at one side of the room **3** *is surrounded by scintillating plastic furniture and lamps. After-dinner coffee is served from a coffee table which stands securely on plastic legs, its leather top laced to a plastic frame. Walls of deep sage green, draperies of Picasso pink faced with dark green, and a Cha-Ming Lustre Broadloom carpet of sea-sand, form a fitting background for the delicate loveliness of the modern plastic furnishings*

Traditional transition

by EVE MAIN

Furniture craftsmen turn their skill to more modern materials

MANY a spontaneous "Oh!" and "Ah!" could be heard as visitors to the Sixth Annual Public Exhibition of 65 Decorators' Interiors, sponsored by Grosfeld House, entered the rooms that mark the beginning of the "Glassic" era in furniture construction. The faithfully reproduced period designs are familiar enough, but in place of nature's wood which one expects to see, is a man-made material—crystal-clear methyl methacrylate which was born in the chemical laboratory.

Every piece of furniture in the Glassic entrance hall, foyer, living room, bedroom, powder room and bar is made entirely or in part of this transparent plastic. The same material is incorporated into the trim of the rooms, into lamps and lighting fixtures. Each skillfully arranged room is a masterpiece of lightness, beauty and charm for cozy, comfortable living.

This dramatic presentation opens an entirely new field for a plastic material which has hitherto been associated with such applications as airplane windshields, lenses, dentures, displays, garment hangers, small decorative articles and so on. There have been a few scattered attempts on the part of enterprising designers to shape rods and sheets into coffee table pedestals, chairs, benches and the like, but these pieces, delicately lovely though they might be, were produced on the one-of-a-kind basis and inclined to be more ornamental than they were practical in production. Actually the Grosfeld House development represents the first appearance of methyl methacrylate plastics in production furniture designed for general sale.

To replace wood in furniture destined for everyday use in the home, this product of science must have merit other than its ethereal beauty. And so it does. Although it may look fragile, it is practically unbreakable and does not chip or split. Nor does it stain.

(Please turn to next page)

4

5

6

A lamp base of glass-like Plexiglas 4 reflects the harmony of planned light and color in an up-to-the-minute interior. Fragile to look at, but mighty durable in service, is a coffee table 5 made entirely of transparent methyl methacrylate material, except for its glass top. In keeping with the modern tempo is plastic door trim 6 of classic simplicity. The molding and fireplace decorations in the living room, where this door trim appears, are also fabricated from man-made plastic material

7

8

The Glassic bedroom fairly glistens with mirrors and light, airy plastic furnishings. In one grouping of pieces **7** *a dainty blue damask chaise lounge seems to float in space since its plastic legs are almost invisible; an efficient plastic lamp balances a scale to accommodate flowers; a tall brown mahogany chest is built with reeded plastic columns and large, easy-to-grip handles; the same plastic appears in a side chair, gadget stand and small table. In another grouping* **8** *is an inviting bed with quilted plastic headboard. Rectangular mirror-topped tables at either side stand firmly on "plume" plastic legs and the plastic bureau, mirror, and molding trim excite more than casual interest. A close-up of the mirror* **9** *shows in detail the skillfully carved Acanthus leaf design of the decoration. One of several graceful side chairs* **10** *combines sparkling Plexiglas with rich upholstery fabric. A plastic dressing table with a rope design carved on the front* **11** *in the Glassic powder room, leaves nothing to the imagination as to its contents. Lamps made of plastic reeds on silver leaf bases give soft, flattering light*

It weighs only about half as much as glass but is as strong as good spruce wood and is equally effective used alone or in combination with wood, glass, leather or upholstery fabric. Joints of the material, securely cemented in place, never come loose and there's no blistering or warping of surfaces because of overheating in homes or apartments.

To look at the finished pieces proudly displayed in the Glassic rooms, one would never imagine the headaches and sleepless nights it took to get them there. For nineteen years, Grosfeld House has been importing and manufacturing fine furniture for an exacting clientele and about a year ago, while conferring with Leon M. Simmons, manager of Grosfeld House, Mr. Grosfeld expressed a desire to make furniture of plastics. He had admired the elegant, decorative qualities of the materials as applied to the design field and felt there was a definite place for them in home furnishings.

From then on, Mr. Simmons has studied and experimented with plastics until he feels personally acquainted with each little molecule in their construction. His task wasn't an easy one because no precedent had been established that adequately covered furniture making of plastics. Every detail had to be cornered and translated into cabinet making terms.

"Our first step," says Mr. Simmons, "was to settle upon the kind of plastics to use. Knowing but little about their general characteristics and possible uses, we investigated several different types gradually eliminating those that were not suitable for our purpose. The transparency and sparkle of methyl methacrylates caught our fancy and they were adopted without hesitation as soon as we learned they had the necessary strength, durability and ease of fabrication.

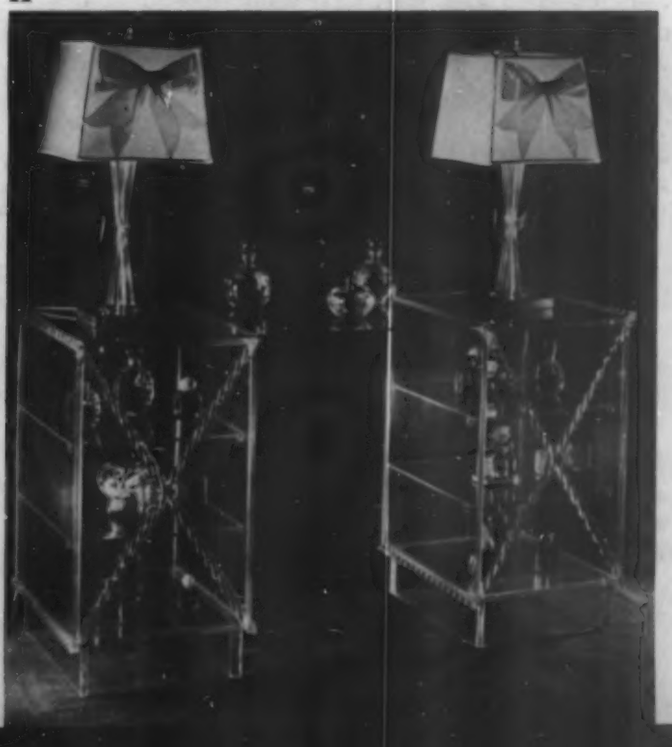
"Next came the question of design. The plastic material being crystal-like and delicate-looking we felt it would best be interpreted into furniture of a light and classic motif. Lorin Jackson, the designer chosen to do the work, entered right into the spirit of the venture with a modern version of Eighteenth Century style. His rough sketches of the pieces he felt would be appropriate were taken by our regular designing staff and put into workable shape to facilitate their manufacture.

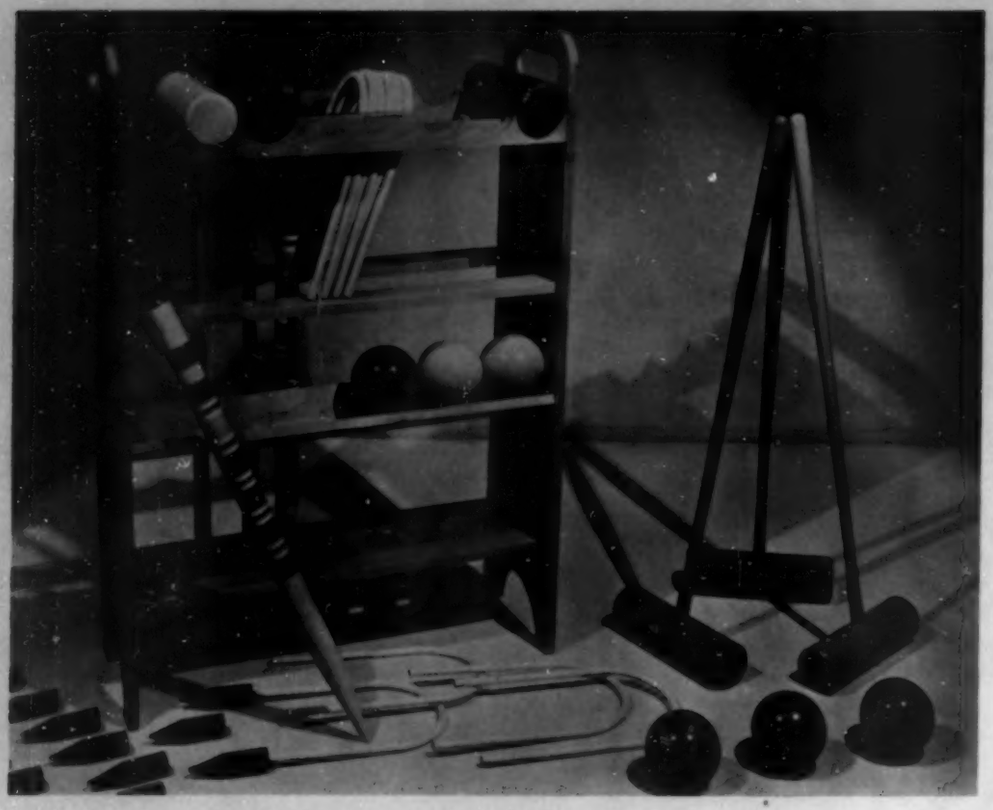
"It was when we reached the point of actually building the furniture that our worries really began. Skilled craftsmen who could take a few pieces of wood and transform them into lovely chairs, tables or cabinets, had to be trained all over again to work with the new material. We found that the plastic could be handled much like wood, but with certain reservations. The speed of wood working machinery had to be changed; special types of tools had to be developed—chisels for hand carving, saws for cutting. Then it was necessary to experiment with ovens to heat the material for bending and shaping. There (*Please turn to page 76*)

10

9

11





Wickets, as well as mallets and balls in this modern croquet set, are made weather-proof, chip-proof and long lasting by a patented dipping process which covers the surfaces with a pyroxylin coating up to ⅛ in. thick

Making croquet tough

New coating process adds years of life to croquet equipment

ONE of the newest and most practical developments in croquet sets for many a decade is a colorful, weather-proof, plastic treated ensemble that will carry on year after year, it is claimed, without the slightest depreciation in looks and serviceability. Now anyone who has ever owned a set of the ordinary kind—wood balls and stakes, and wire wickets—knows how disappointing it is to drag the kit into the open, come Spring, only to discover that one, two or more of the balls have split. Or that they have warped until they wobble across the grass like a lame duck. Or that the identifying band of color around the center has become so chipped and soiled that it is visible only at close range. Or that the wire arches have rusted.

Even hard rubber, conceded by experts to be the finest material for croquet balls, has its drawbacks. The lacquer used for coloring chips and wears off. Then, too, hard rubber balls are heavy—weigh a pound a piece at least—and the mallets used to bat them around are equally weighty. So although the player gets greater precision with the heavy mallet and balls, only a few thousand of the more skillful use them.

The modern croquet outfit, introduced by Bright Plastics, Inc., makes a high bid for favor among followers of the game for several good reasons. The balls in the set have a wood core, but the wood is encased in a coat of pyroxylin up to $^1/_8$ in. thick. These plastic coated balls are almost perfectly round—within ten thousandths of an inch—and will stay round even under the terrific punishment they must take from both the game and the weather. Their brilliant solid plastic colors—red, green, yellow, orange and blue—can be spotted from any part of the court. And one of the most satisfying things about them is that they won't break, crack or chip.

The wood mallet head and handle is treated to a plastic coating, too, which helps make the union between the shaft and the head a permanent one. Not much danger of the head taking off after the ball all unexpectedly. This mallet, with its smooth, sure grip, is really strong as well as light in weight. The metal wickets in the set are also plastic coated to make them weather-proof and chip-proof.

The pyroxylin coating on these (*Please turn to page 84*)

Announcing
FIFTH ANNUAL MODERN PLASTICS COMPETITION

FOR the Fifth consecutive year, MODERN PLASTICS COMPETITION is sounding *Reveille*—the annual call to the plastics and allied industries to bring before a far-flung, interested audience the latest developments and improvements in plastic materials and the techniques of handling them.

MODERN PLASTICS COMPETITION is more than an exhibit of "good things well done." It is a guide to plastic manufacturers and potential users of plastics for their own selection of suitable materials for new applications; a representative demonstration of the practical, economical and distinctive properties of these man-made materials.

And to the Winners, the Competition affords a threefold opportunity for public recognition: first, the MODERN PLASTICS Plaque of Award; second, a distinction which most winning sponsors have capitalized to consumers and dealers through all possible advertising media; third, valuable publicity (at no cost) through articles and pictures in hundreds of newspapers, journals, motion pictures, traveling exhibits, professional society and government displays. In addition, a new sound and color film, available to business organizations and colleges in every state, will include the 1940 winners.

Classification of Entries

The tremendous growth of the Competition as well as the substantial increase in plastic applications in every industry has made necessary a re-classification and expansion of the various divisions. Entries will be grouped according to the type of application or according to the industry or field in which they are being used. These divisions, we believe, offer a more natural and desirable grouping, admitting a wider scope of applications.

The new classifications:

1. **Architecture**
2. **Business and Office Equipment**
3. **Communications**
4. **Decorators' Accessories**
5. **Furniture**
6. **Household**
7. **Lighting**
8. **Machinery & Appliances (Industrial)**
9. **Novelties**
10. **Scientific**
11. **Sporting Goods, Games & Toys**
12. **Style and Fashion**
13. **Transport**
14. **Miscellaneous**

NOTE: Photos of architectural entries must be accompanied by actual samples of the plastic material to show color and texture of the application.

There will be three awards of equal standing in each group, if sufficient entries warrant such recognition. If any of the above groups does not have sufficient entries to constitute competition on the closing date, it will not be judged. Rules for entering are clearly stated in the entry form opposite the following page. Additional entry blanks will be sent upon request.

Make an early start. The closing date of the 1940 Competition is August 15—two weeks earlier than in previous years. All entries must reach our editorial office by that date. Judging will follow immediately.

MODERN PLASTICS COMPETITION is *your* exhibit. It is your opportunity to focus the attention of all industry on your product—win authoritative recognition and prestige.

Put your plastic products on parade. Send your entries to FIFTH ANNUAL MODERN PLASTICS COMPETITION. There is no entry fee. No obligation whatsoever. Use Entry Form opposite following page.

ALFRED AUERBACH

HARVEY WILEY CORBETT

THESE SEVEN JUDGES WILL CHOOSE THE MOST DESERVING ENTRIES IN THE 1940 MODERN PLASTICS COMPETITION

★ ★ ★

J. DELMONTE

WILLIAM A. KIMBEL

MORRIS B. SANDERS

A. M. SWIGERT

ALL ENTRIES MUST REACH OUR OFFICES ON OR BEFORE AUGUST 15, WHICH IS THE CLOSING DATE. JUDGING WILL TAKE PLACE IMMEDIATELY AND WINNERS WILL BE ANNOUNCED IN OUR OCTOBER ISSUE

HAROLD VAN DOREN

Alfred Auerbach, editor of *Retailing*, is well known on the home furnishings scene and an authority on marketing and distribution.

Harvey Wiley Corbett, has served with each Board of Judges since the inception of our Annual Competition in 1936. He is a member of the firm of Corbett and MacMurray, architects.

J. Delmonte, instructor in Plastics at Armour Institute graduate school and assistant to the Chief Engineer, Chicago Flexible Shaft Co., is the author of *Plastics in Engineering*, recently published, and has been a frequent contributor to MODERN PLASTICS' editorial columns.

William A. Kimbel, president of the American Institute of Decorators, is a prominent decorator and president of Accessory Timepieces.

Morris B. Sanders, serving his fourth year as a member of our jury, is an architect and design engineer, who has been using plastic materials in his interior designs for many years.

A. M. Swigert, is a member of the Production Research Division Staff at the Jefferson Ave. plant of the Chrysler Corporation.

Harold Van Doren, industrial designer, with many successful plastics, is the author of the recently published book, "*Industrial Design, A Practical Guide.*"

Student design

Publishing these designs does not necessarily indicate that we subscribe to their merit. It is important, however, to note that manufacturers are becoming more and more conscious of good design and, recognizing its influence in the sale of their products, are taking steps to promote it. This is particularly true in the plastics field. (EDITOR)

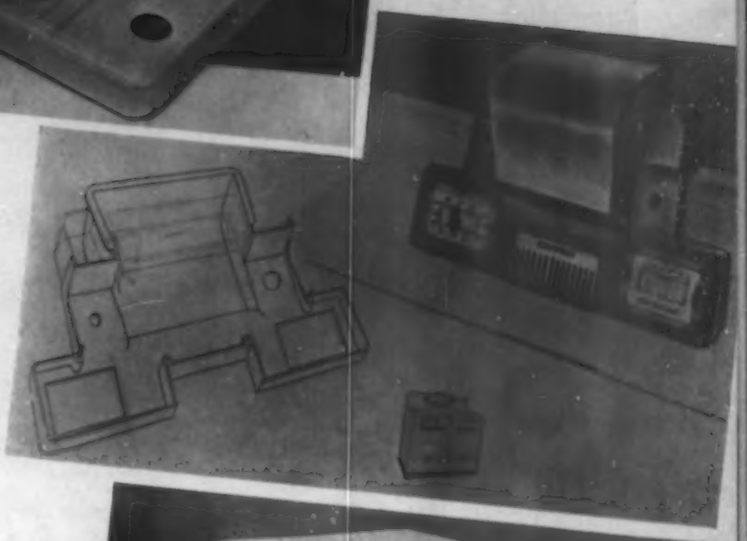
INDUSTRIAL design will be led into new pathways but not subjected to impractical change by the younger generation, if the results of the creative design competition in plastics sponsored by the Plaskon Co. among the students of the Carnegie Institute of Technology set any criterion.

Designs submitted indicated that the students wished to advance but that they also had a mature understanding of the value and progressive nature of the ideas already established in the principles of modern design.

Although working with a plastic for the first time, the student designers found the properties of the material stimulating and helpful to them in arriving at the elegance of shape and attractiveness of surface and color for which they were striving.

Streamlining was conspicuously avoided. Students showed a definite trend toward the creation of designs which were logical from a functional as well as an aesthetic standpoint. Both men and women participated, and the common standard of quality and the unanimous agreement as to what constitutes good design appeared to establish that women, as much as men, are capable of industrial design. (*Please turn to page 78*)

1



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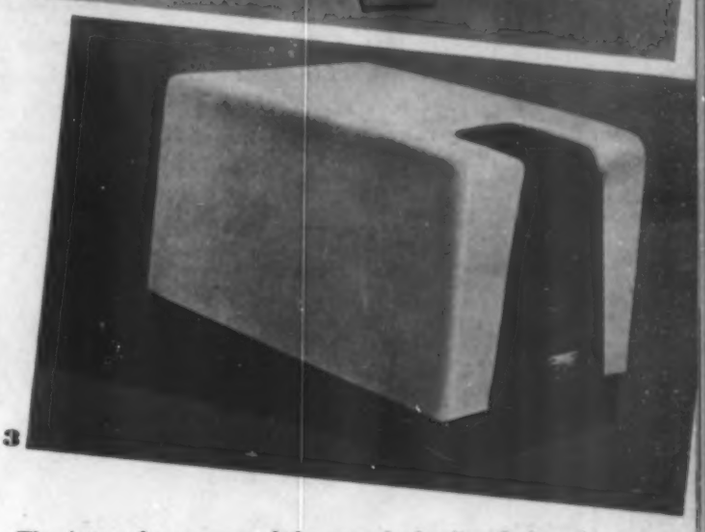
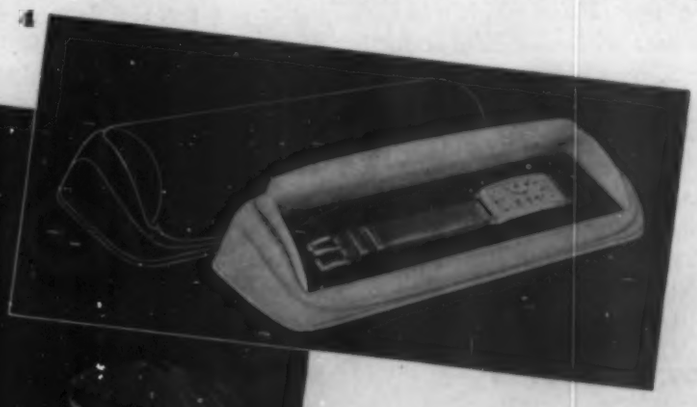


3

We picture here some of the award winning designs in a creative design competition in plastics sponsored by the Plaskon Co. among students in the Department of Painting and Design, Carnegie Institute of Technology. First prizes ($50.00 each) were awarded to Gilbert McMurtrie for his airline tray 1, to Frank J. Zavada for stove hardware 2, and to William Winterbottom for a kitchen scale 3. Raymond Cyphers received second prize ($25.00) for a watch package 4. Cosmetic containers 5 won an honorable mention for Marjorie King



4

5

Officers and directors of S. P. I. for the ensuing year are pictured above. Bottom row, beginning left: Donald Dew, chairman of the board; Henry J. Kasch, president; Kenneth W. Macksey, vice-president. Center row: William A. Freyer, director; E. F. Lougee, secretary-treasurer; and George Sicard, acting secretary treasurer. Top row: Charles Romieux, Charles Lichtenberg, William T. Cruse and Allan Fritzsche, directors

S. P. I. at Hot Springs

THE annual business meeting of the Society of the Plastics Industry was held on April 14 to 16, at the Hotel Homestead, Hot Springs, Virginia. Snow greeted those arriving on Saturday and Sunday but this quickly gave way to beautiful weather on Monday which was ideal for golf.

The Directors held a meeting Sunday evening but the main business meeting took place in the Homestead Theater, Monday morning at 9 o'clock. Charles A. Breskin, chairman of the nominating committee, presented the slate of new officers which was unanimously elected from the floor without debate or further nominations. Henry J. Kasch, Kurz-Kasch, Inc., Dayton, Ohio, was elected president; Kenneth W. Macksey, Mack Molding Co., Wayne, N. J., vice-president; E. F. Lougee, editor of MODERN PLASTICS, New York, secretary-treasurer. William T. Cruse, Celluloid Corp., New York; Allan Fritzsche, General Industries Co., Elyria, Ohio; Charles Romieux, Beetle Div., American Cyanamid Co., New York; William A. Freyer, Auburn Button Works, Inc., Auburn, N. Y.; and Charles Lichtenberg, Resinox Div., Monsanto Chemical Co., Springfield, Mass.; were elected directors. Donald Dew, Diemolding Corp., Canastota, N. Y., retiring president, automatically became chairman of the board for the ensuing year.

Immediately following the business meeting, R. F. Wyer, welding engineer, General Electric Co., presented a paper on "Hydrogen Welding of Molds and Other Steel Parts." This Technical Session was under the guidance of Hans Wanders, Northern Industrial Chemical Co., Boston, Clinton Blount, Bakelite Corp., N. Y., and Gordon M. Kline, U. S. Bureau of Standards. Dr. Kline presided in the absence of Hans Wanders, who was chairman.

Official tournament golf occupied the afternoon and prizes were awarded at the annual banquet which was held in the Empire Room at 7:30, Monday night. Charles F. Hamilton, Detroit office of Kurz-Kasch Co., regimented the golfers and presented the awards. William B. Hoey, Detroit office of Bakelite Corp., presided as master of ceremonies.

The committee in charge of all arrangements was headed by Charles H. Frantz, Kurz-Kasch Co., with Paul Tietz, Richardson Co., Chicago, Bill Hoey and Charles Hamilton in collusion. It was a grand committee and everybody admired the smooth operation of every detail of the progam. This, by the way, was the first annual meeting of the Society held entirely under the direction of the Western group of members and at a place and dates designated by them.

Among those attending were: American Cyanamid Co.: H. T. Coghill, G. W. Patterson, C. J. Romieux, William F. Torres; American Insulator Corp.: George A. Johns; Arrow-Hart & Hegeman Elec. Co.: George W. Carlson; Associated Attleboro Mfrs. Inc.: C. W. Douglas; Auburn Button Works, Inc.: George P. Anderson, W. A. Freyer; Bakelite Corp.: R. E. Brannon, Allan Brown, Gordon Brown, Sanford Brown, W. B. Hoey, D. A. Munns, R. A. St. Laurent; Bryant Electric Co.: R. H. Cunningham, C. J. Smith; Carbide & Carbon Chemicals Corp.: H. S. Bunn, George C. Miller; Celluloid Corp.: W. J. A. Connor, William T. Cruse, W. R. Porter, Edward W. Ward; Chicago Molded Products Corp.: M. C. Bachner, E. M. Maywald; Diemolding Corp.: Donald Dew, Wallace B. Ross, Norman L. Stafford; E. I. du Pont de Nemours & Co., Inc.: Leslie B. Gillie, W. A. Joslyn, D. D. Payne, W. E. Rahm; Durez Plastics & Chemicals, Inc.: A. W. Hanmer, Jr., J. S. Miller, H. S. Spencer, G. W. Wilcox, E. E. Woodman; Durite Plastics, Inc.: F. A. Morlock; General Electric Co.: T. E. Giblin; General Industries Co.: Allan W. Fritzsche, O. W. Marsh; Hercules Powder Co.: Theodore Marvin, Mahlon G. Milliken; Wm. L. Kelly; Kurz-Kasch, Inc.: Charles H. Frantz, Charles F. Hamilton, Henry J. Kasch, Henry J. Kasch, Jr.; Mack Molding Co.: D. S. Kendall, Kenneth W. Macksey, James McIntosh; Makalot Corp.: M. M. Makeever, C. R. Olson; Elmer E. Mills Corp.: (*Please turn to page 78*)

ALL PHOTOS BY CHARLES BRADLEY

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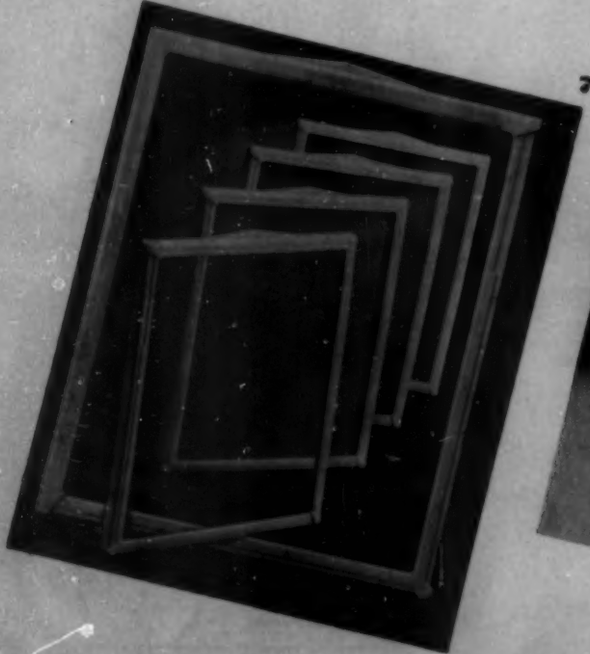

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Plastics in Review

1 Conical caps and a 3-step base of ivory Plaskon set off the vivid hues of Contouré nail polish. Designed for A. Breslauer Co. by Sidney Handel, the display stand was molded by General Electric. Colt's Patent Fire Arms Mfg. Co. molded the closures

2 Tiny badges, facsimiles of their own tractors, roll up orders for salesmen of the Caterpillar Tractor Co. Complete in every detail—even to pipe line and exhaust—these premiums are molded of Lumarith by Cruver Mfg. Company

3 Daggett & Ramsdell preparations wear new finery for the company's Golden Jubilee. Modern caps in pastel tints complement the Victorian embossed bottles, and they're unaffected by cosmetics. Plastics, Inc., molds them of Bakelite polystyrene

4 Corn-on-the-cob, steaming hot, without burning or soiling your fingers—just grip the bright cast resin handles of these metal corn holders and, Mmmmm! They're fabricated of Gemstone by J. M. King Mfg. for John Lauterbach Co. Some also are molded of Beetle.

5 Removable, interchangeable parts in the Pilgrim pen, made by Le Boeuf Pen Co., minimize repair problems and allow assembly for individual requirements. Pen and pencil barrels are of Monsanto cellulose nitrate in a colorful chevron pattern

6 Quick Watson! You don't have to hunt for RCA Victor's new Long-Life phonograph needle. It's packaged in an individual, transparent, rectangular Bakelite polystyrene container. The needle is set in a hollow niche in the center of one block and topped by another which bears the company's tradename in red

7 For candid camera shots or family portrait, smooth, durable plastic picture frames, simple in design, fit in any decorative scheme. They're injection molded of Tenite in several sizes by Gits Molding Corporation

8 Dinner at 8—with handsome place cards of your own design. This ingenious hostess set includes 12 Lumarith plaques, two shades of ink, remover, a special pen and little plastic stands. Celomat Co. is the distributor

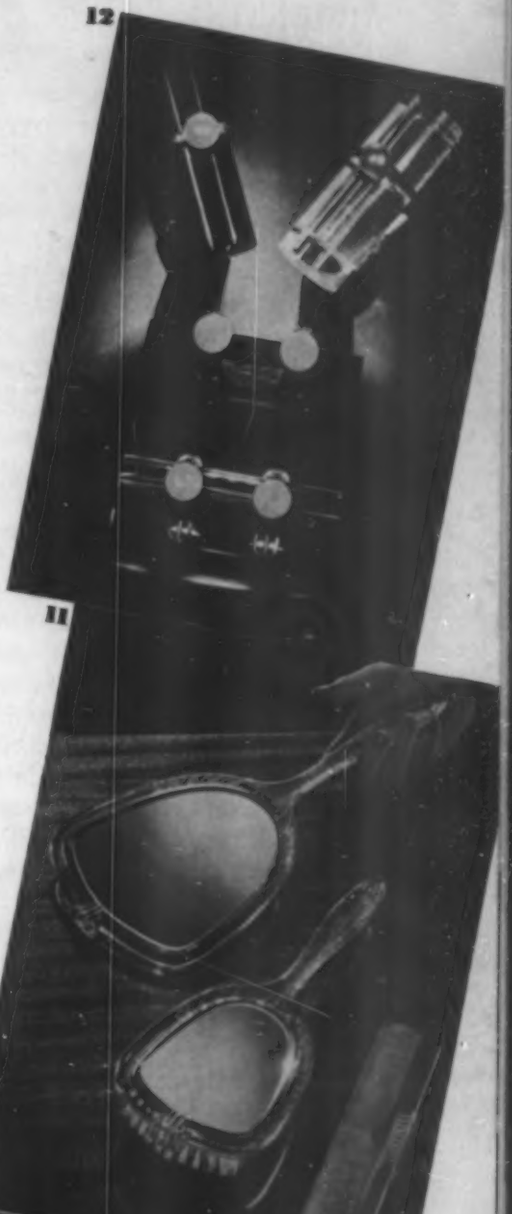
9 Appetite-tempting, illuminated natural color photographs of frosted foods, mounted on Kelvinator storage cabinet catch the shopper's eye. They're printed by a special color-reproducing process developed by Morgan Lithograph Corp., on rigid sheets of Monsanto cellulose acetate which slide on the panel

10 Weep no more. The Washburn Co.'s Tearless Onion Chopper seals the fatal aroma in a glass measuring cup with a close-fitting Durez cover. A removable wood block fits on bottom and a 4-blade chopping knife is operated manually as a plunger. Globe Tool & Molded Products Co. molds the cover

11 Ornamental dresser sets with a delicate, hand-carved look, have lightweight, strong frames of Tenite. They're injection molded in clear transparent and pastel shades by Plastic Molded Arts, Incorporated

12 Simple sparkling displays for precious jewels are machined from clear and black Plexiglas rods, 1/2 in. to 3/4 in. in diameter. Earring stands are made by cutting slots across the rod. Made by Bayard F. Brogan

For manufacturers' addresses write to the Editor, enclosing self-addressed stamped envelope for reply



South American trade in organic plastics

ARGENTINA

(Vice Consul Joe D. Walstrom, Buenos Aires)

This is the first of a series of surveys on South American trade in organic plastics being undertaken by the Chemical Division, Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce, for the purpose of aiding United States manufacturers to secure orders for such products as well as for machinery employed in fabricated finished plastics articles. Other surveys will be published here as released. (Editor)

THE production of organic plastics in Argentina is still in a very preliminary stage, and it will doubtless be some time before local producers can supply an appreciable share of the demand.

Argentina is an important producer of casein, but practically all of it is exported. Only recently has galalith been manufactured in the country on a commercial scale, and total production is still very small. There are also a few small firms endeavoring to produce phenol-formaldehyde plastics in powder form, in the black and brown colors which are the easiest to make.

Domestic production of galalith and synthetic resins has been encouraged by increasing prices and the difficulty in getting deliveries from Europe, but as yet it has scarcely passed the experimental stage, and it remains to be seen whether the local industry will grow after the war is over.

Fabrication of plastic articles

There are six or seven important firms in Buenos Aires fabricating from semi-finished plastics, as well as numerous smaller firms with a more restricted output. Thermosetting plastic materials (of the phenol-formaldehyde and urea types) account for most of the local production, and a full range of articles is manufactured within the country. Cellulose acetate powder has been employed to a limited extent, but the Argentine market is not large enough to justify the large-scale production of many items from this material, therefore its use has been limited to the manufacture of tube caps, combs, and lipstick holders. A local fountain pen manufacturer also intends to produce fountain pen and pencil barrels within the near future. Some cast cellulose materials are imported in the form of sheets and rods for local production of novelties and other pyroxylin plastic products, and there is also local manufacture of buttons, ornaments, and similar items from galalith, most of which is imported.

All of the domestic companies manufacturing from plastics are nominally Argentine, although the principal producer of finished articles and the aforementioned fountain pen factory are controlled by American capital.

It may be said that Argentine sales possibilities for new plastic articles have been fairly well explored, and the only reason additional items are not made locally is that the potential demand does not justify the investment in dies or in more modern machinery.

Marketing methods

The domestic production of plastic materials has not yet reached the point where any definite distribution channels have been established. In one case, galalith is produced by a factory for its own consumption, and in another case galalith sheets are offered to wholesalers and consumers by a firm which does not manufacture any finished articles. The small amount of phenol-formaldehyde plastics has been offered by the manufacturers to the prospective consumers.

Imported plastic materials are generally represented by local agents, who carry samples and solicit orders from the consumers, with most shipments being sent direct. As a rule, agents do not carry stocks. Any consumer not large enough to place a minimum order for direct shipment is obliged to purchase small lots through limited wholesale outlets.

A very large part of the finished goods is manufactured on a contract basis, that is, on special order. Aside from the production of bottle caps, which is said to account for over two-thirds of the total output of the Argentine plastics industry, most of the finished items are accessories to or components of other commercial products. In most cases these articles are made up on special order from the manufacturer or assembler of the finished item. This class of consumers is usually anxious to have the exclusive use of its pattern, which precludes the use of the dies for manufacturing similar articles for sale on the open market.

The Argentine market is so limited that any order in quantities of say 5,000 units (apart from bottle tops and tube caps) is considered a very substantial order. Whereas box covers, buttons, dishes, and other relatively common and non-exclusive items are sometimes produced for stock and for the wholesale trade, the nature of the market as described above does not encourage the large-scale production of specialty articles in the absence of definite orders. Consequently, most orders for plastic articles are placed directly with the local manufacturer, rather than purchased through wholesalers.

Buenos Aires is not only the center for plastics manufacture and fabrication, but it is also estimated that at least 75 percent of the finished plastic articles are likewise sold in Buenos Aires.

Import trade

Since the domestic production of plastics is still on a limited scale and no statistics for them are available, the following import figures will give a fairly accurate idea as to the country's total consumption:

IMPORTS OF PLASTIC MATERIALS
(In Kilograms)

Class and Country of Origin	1937	1938	1st 9 mos. 1939
Bakelite in general, unworked			
United Kingdom	197,771	161,617	168,222
Germany	194,399	157,439	138,216
France	4,866	8,091	9,717
United States	1,256	9,437	3,994
Czecho-Slovakia	25,076	6,962	3,710
Estonia	16,331	1,515	5,990
Netherlands	4,494	7,281	3,085
Others	17,905	7,900	1,836
	462,098	360,242	334,770

Class and Country of Origin	1936	1937	1938
Celluloid sheets for stamping or printing:			
Japan	56,417	50,733	61,476
Germany	17,536	39,759	31,466
Others	389	1,643	1,222
	74,342	92,135	94,164
Pyroxylin plastics in sheets, rods, and tubes:			
Germany	134,760	149,730	116,192
Japan	81,405	84,111	64,023
Others	94	292	84
	216,259	234,133	180,299

Separate statistics are not available on galalith or other plastic materials.

The import figures on finished plastic articles are not classified in such a way as to give an accurate idea of the trade in this field. Although the large bulk of the items made from thermosetting plastics is manufactured within the country, there is still a substantial import trade in articles and novelties made from other types of plastics, where the demand is not large enough to justify domestic production. In normal times Germany and Czecho-Slovakia were the leading suppliers of finished plastic articles, with Japan also prominent in pyroxylin plastic novelties.

Import duties

Thermosetting plastics are generally imported under the tariff classification of "bakelite in general, unworked," paying 42 percent on an arbitrary fixed valuation of 0.60 gold peso per kilogram.

Celluloid in sheets for stamping or printing is assessed 42 percent on an arbitrary valuation of 2.08 gold pesos per kilo. Celluloid in sheets, or thread, pays 42 percent on a valuation of 0.96 gold peso per kilo.

Items not specifically classified in the Argentine tariff generally pay 42 percent on declared invoice value. While tariff valuations are expressed in gold pesos, the monetary unit in circulation is the paper peso, equal to 0.44 gold peso.

Import duties on finished plastic articles would vary considerably, depending on description of the article. In cases where there is a specific tariff classification, the rate of duty would generally be assessed on the basis of a fixed valuation per kilogram. Where the article would not come under a specific tariff schedule, the duty would be 42 percent on declared invoice value. (Any attempt to give a comprehensive list of duties on finished plastic articles would be impractical, as in many cases the duties could not be determined without making a trial importation or else by consultation with customs authorities or customs brokers.)

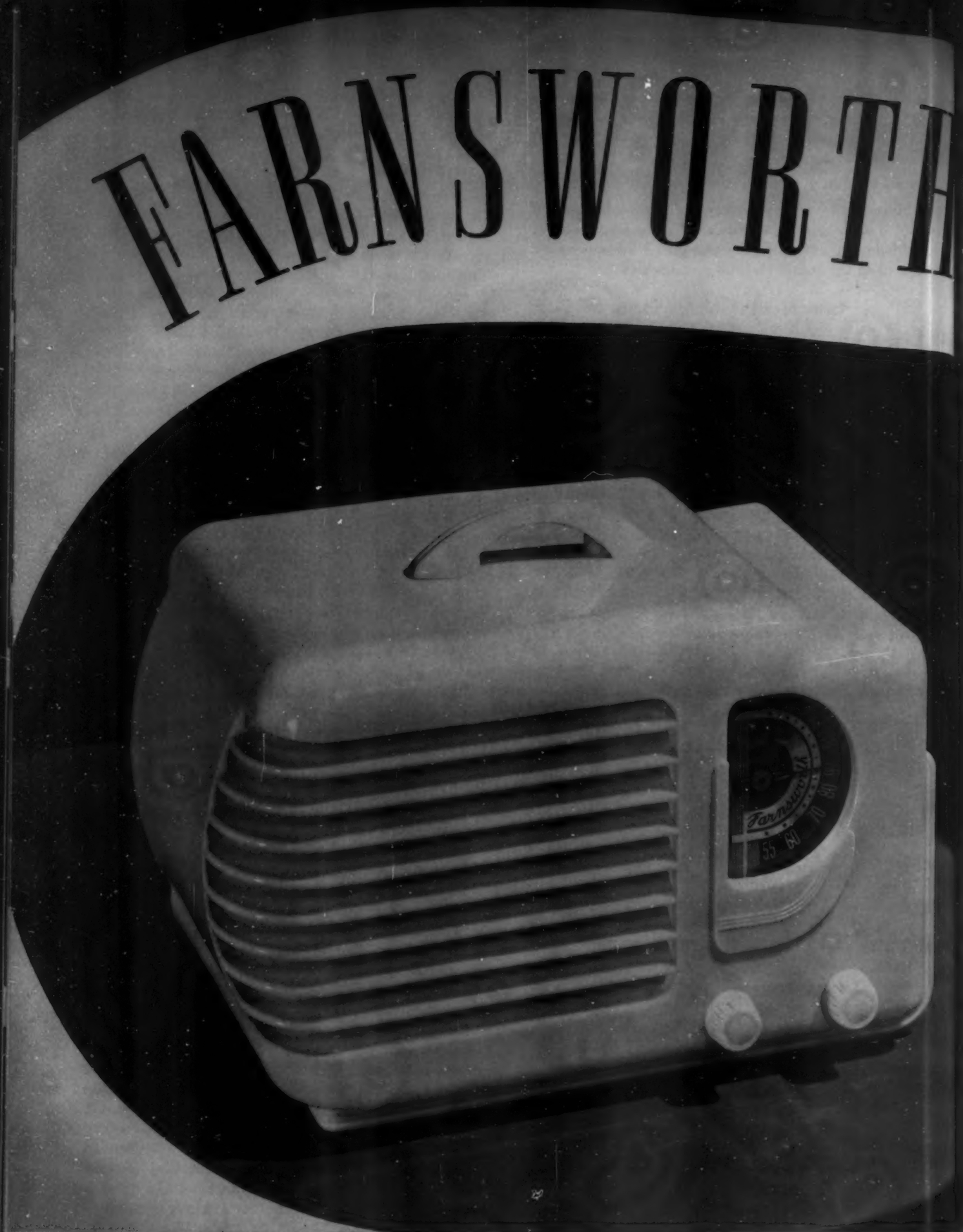
While there are general regulations affecting the importation of inflammables, local importers advise that there are no special requirements applying to plastic products.

Competitive factors

The United States has not been an important supplier of either plastic materials or finished articles in the Argentine market, the main reason being that European prices usually have been much lower. Also, British and German firms offered more liberal credit terms. Before the war German terms extended as long as four or five months, and British firms quoted on the basis of 30 or 60 days. It was often customary for American companies to ask sight draft terms, although it is understood that some of them have recently offered more liberal credit facilities.

Since the beginning of the war Germany and Czecho-Slovakia have ceased to supply the Argentine market. While there have been occasional delays in receiving orders from the United Kingdom, there is no indication that the British share in this trade has declined. A number of the local firms have been so accustomed to working with British plastics that they are hesitant to change. Some importers have claimed that German materials were sometimes not uniform as to quality, but this was more than offset by low prices and long terms.

A part of the business formerly obtained by Germany has been diverted to the (*Please turn to page 84*)



The intricacies of the Farnsworth radio cabinet are illustrated in this photo, and aptly demonstrate the possibilities of solving complicated molding problems with Molded Plaskon.

This cabinet measures 10½" wide, 7" high, and 6¼" deep. It is molded for the Farnsworth Television and Radio Co., Fort Wayne, Indiana, by International Molded Plastics, Inc., Cleveland, Ohio.

The Newest Name in Radio

● A few months ago, the Farnsworth Radio was presented to America.

It is more than just the newest radio in the country. It is a radio as modern as tomorrow... keyed to the swift pace of scientific developments in the radio field.

Of course, a radio so new and revolutionary must dress the part. And Molded Plaskon was chosen for models such as shown at the left... gay, sparkling cabinets that bespeak smart performance and rich quality.

Plaskon moldability for difficult one-piece jobs is aptly illustrated by the intricacies of the Farnsworth cabinet design. And there are a great many other Plaskon features that determined its selection by Farnsworth.

Molded Plaskon is smooth and warm to the touch. Though light in weight, it has great strength—will not chip, corrode, rust or tarnish. Its surface is hard, easy to keep clean. Water, oils and organic solvents will not stain or otherwise affect the beauty of Molded Plaskon. Being solid molded color, the finish is permanent. Neither scratching nor abrasion impair its color value.

These are but a few of the many distinctive qualities that have made Plaskon the world's largest selling urea-formaldehyde plastic—and one of the most versatile.

Buttons and Buckles—Bottle Caps—Cosmetic Containers—Handles, Knobs and Dials for Motor Cars, Radios, Electrical Appliances—Lighting Reflectors —Switch Plates and other Electrical Wiring Devices — Toys and Novelties — these represent only a fraction of the wide variety of applications to which Plaskon has been adapted successfully and with profit.

An experienced Plaskon representative will give you recommendations for adapting Plaskon to your manufacturing and product-development needs. Write or wire—no obligation!

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A Letter from London

LONG term research in the British plastics industry is now almost static, most of the scientists being mobilized for immediate work in industry or Government departments. As a result of this neglect, unavoidable as it may seem in the present circumstances, it is feared that the plastics industry in this country will emerge from the war a good way behind the United States both as regards new materials and new processes of fabrication. It might be added that Germany, where plastics are now being rationed, is not likely to be any better off as her chemists and physicists, engineers and technologists are being forced to subjugate everything to the war effort. There is little truth in the oft-repeated assertion that war is responsible for a great acceleration of scientific effort. True, research is speeded up in certain directions allied to the war effort, such as explosives, aeronautics, fuel, etc., but, generally speaking, the results do not lend themselves to exploitation by normal peace-time industry.

There is at the present time a great interest in plastics by aircraft manufacturers, but the work now being carried out can hardly be called research as the scientist understands it, rather is it a kind of *usage investigation* where the material, which is considered to be static, is utilized for new purposes. Thus plastics are being turned over to the designer and engineer for examination and they are led to consider them as standard materials. This is a pity because plastics far more than light alloys and wood are essentially fluid materials which can be adapted to certain service conditions.

All this may appear to be merely of academic interest —a nice little problem for discussion by a college debating society. On the contrary, however, it is one of immediate and also far-reaching importance to the British plastics industry which is now enjoying an unstable wartime boom due to the scarcity of metals and wood. When peace returns these materials will be released for normal use and there will be an immediate reaction away from plastics. It is not unreasonable to suppose that the industry will be faced with a state of affairs very much like a slump. To offset this possible depression plans should now be made and research carried out so that the industry will, when sanity returns to the earth, be able to offer improved materials and methods of fabrication. Such a course would be an insurance for which the premiums could hardly be too large.

In connection with airplane construction and certain War Office contracts there is a growing demand for urea-formaldehyde glues. In the past, users of urea-formaldehyde glues have always experienced considerable difficulty in securing good joints between badly fitting surfaces. Even when reasonably good joints were obtained shear tests showed that their strength was much lower than that of a similar joint made between closely fitting surfaces. Dr. N. A. de Bruyne, brilliant young Cambridge scientist, director of Aero Research Ltd., Duxford, Cambridge, has now been able by controlling the pH of the polymerization of the resin to bridge gaps of as much as 20/1000 in. and yet obtain joints as strong as those made between close-fitting wooden surfaces. This is due to the fact that whereas in the case of ordinary urea-formaldehyde resin the solidified mass formed between the joints crazes badly due to physical changes taking place in the interior of the mass, with the new hardener now on the market the resin polymerizes to form a solid and perfectly homogeneous mass possessing the maximum strength. It can be readily appreciated that the introduction of this new hardener is of considerable importance to the aircraft manufacturer as it eliminates a lot of laborious and lengthy finishing and so speeds up production. The following figures clearly show the value of the new hardener for various gaps of joints.

TEST RESULTS

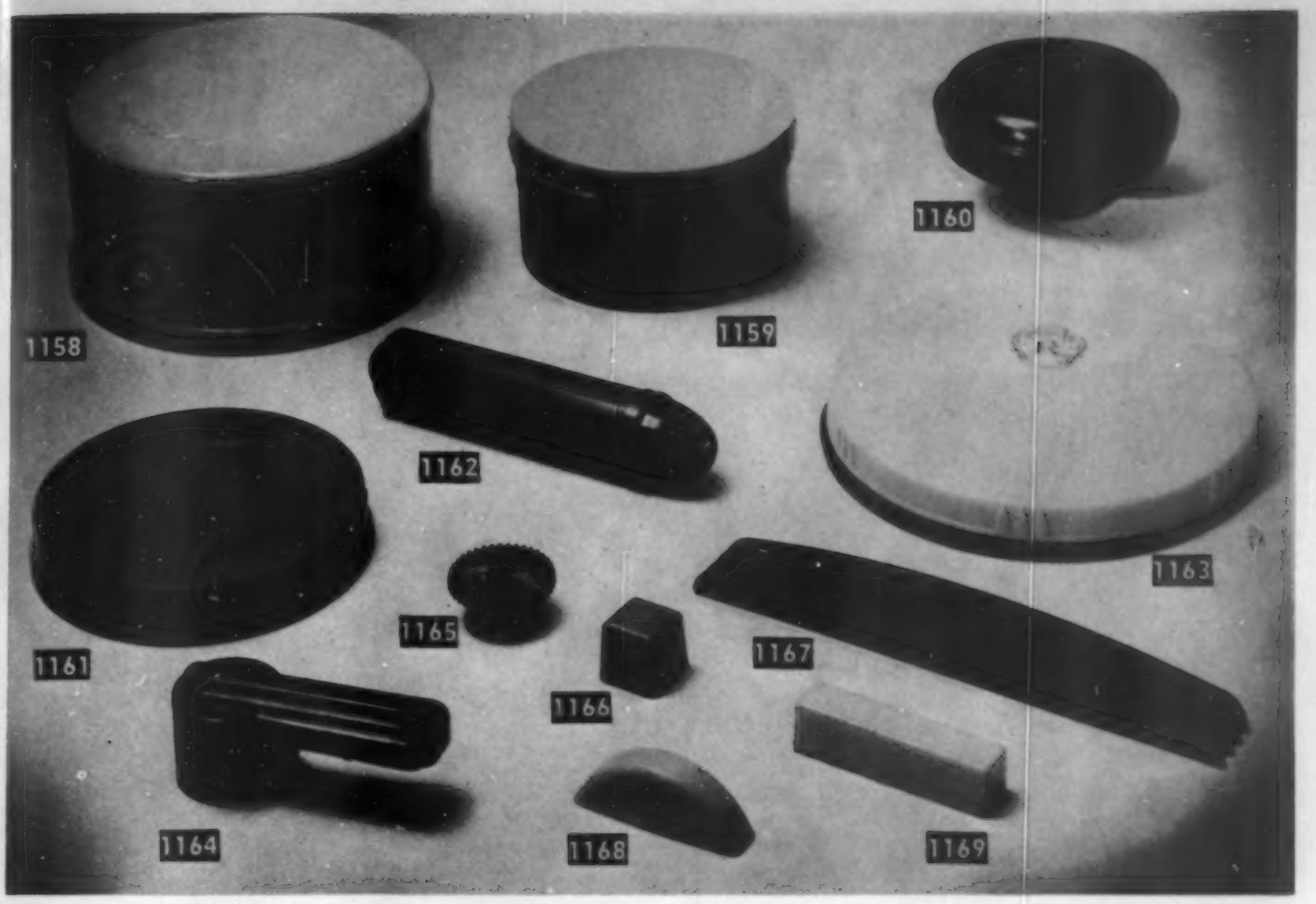
Gluing Conditions								
Gap in.	Pressure lb./in.	Apparent shear stress lb./in. of glued surface						Average lb./in.
0.020	Nil	1264	1213	1275	1360	1200	1226	1256
0.010	Nil	1335	1240	1162	1227	1370	1560	1316
0.005	Nil	1124	1118	1201	920	1015	1065	1074

A large number of inquiries are now being obtained by molders from manufacturers desiring to replace plastic for metal parts. True, a large proportion of these never take shape as definite orders, but a growing percentage do become actual jobs. A very interesting new molding is the all-plastic bicycle rear lamp made by Byson Appliance Co. Ltd., Bury. The body is fabricated of a phenolic resin and the ruby lamp or lens is molded of cellulose acetate. Another item of special interest is the outlet control for a large size car and ambulance heater. This is molded of special heat-resisting phenolic resin able to withstand a constant temperature of 160 deg. F. The molding measures 7⅜ in. in diameter and is equipped with a central exterior knob able to rotate an inner slotted disk which, when made to coincide with the apertures in the outside molding, allows hot air to pass from the heater. This molding is the work of the English General Electric Co. Ltd., made for car heaters constructed by Hallam, Sleigh and Cheston, Birmingham. One of the reasons why plastics was chosen for this particular application, apart, of course, from the difficulty of obtaining metal, was that it was free from all corrosion and consequent sticking of the outlet control.

News of the *Queen Elizabeth's* dramatic trip across the Atlantic has naturally been a subject of considerable comment in the world's press. So far little if anything has been published about her fittings, some of which are still incomplete. It is, however, known that plastics have been widely employed even to a greater degree than on the *Queen Mary*.

Excellent progress is being made with the three factories which are being built in England for the manufacture of nylon. One of these, which will produce the *polymer* is being erected at Huddersfield by the I. C. I. Dyestuffs Group. The other two, both of which will be engaged in converting the raw material into the intermediate products, monofil and yarn, which will be sold to their respective industries, are at the works of I. C. I. (Plastics) Ltd., Welwyn Garden City, and at the British Nylon Spinners Ltd., a joint company formed by Imperial Chemical Industries Ltd., and Courtaulds Ltd., Coventry.

John S. Thorn



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Stock Molds

SHEET NINETY-FIVE

Colorful compacts, powder jars, flashlight and miscellaneous knobs and handles are available without mold cost from stock molds. Address Stock Mold Department, Modern Plastics, Chanin Building, New York, for manufacturers' names and addresses

---

1158. Powder box fitted with bottom closure card and sifter. Diameter 3 3/16 in.; overall height 2 5/8 in. Contrasting cover 1/8 in. high

1159. Molded box or 2 oz. jar, 2 1/4 in. in diameter; 1 3/8 in. overall height. Inside depth 1 1/16 in. Threaded cover in contrasting color 2 3/8 in. in diameter, 15/16 in. high

1160. Round knob with variable metal insert. Diameter 2 1/16 in.; overall height 1 3/16 in. Hub is 7/8 in. in diameter

1161. Compact, 2 1/2 in. in diameter; 7/16 in. overall height. Inside depth 1/4 in. Threaded top 2 3/8 in. in diameter, 5/16 in. high

1162. Pocket-size flashlight in colors. Overall length 3 1/4 in. Barrel 2 1/4 in. by 9/16 in. inside, faceted outside. 1/2 in. threaded nozzle. Pushbutton and nozzle in black

1163. Flat compact, 3 5/16 in. overall diameter. 7/16 in. overall height. Inside depth 1/4 in. Threaded cover in contrasting color, decorative edge. 3 3/16 in. in diameter, 5/16 in. high

1164. Gas lever handle in red with ridged top, 1 7/8 in. long. 3/4 in. diameter base with 3/8 in. opening

1165. Knurled knob, 3/4 in. in diameter, 3/8 in. high. Base 1/8 in. in diameter, with 1/8 in. opening

1166. Square knob, 7/16 in. high, 3/8 in. top. Base 1/2 in. square with 1/8 in. diameter opening

1167. Ribbed handle, 4 in. long, 3/8 in. high, 1/2 in. wide Two 1/8 in. openings at base

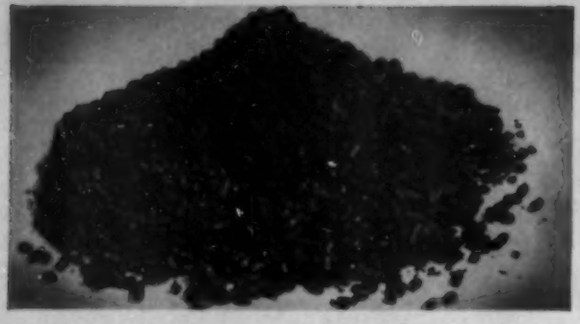
1168. Half-round knob, 1 1/4 in. in diameter 3/8 in. wide, 7/16 in. high. 1/8 in. opening at base

1169. Rectangular knob, 1 3/8 in. long. 3/8 in. wide, 3/8 in. high. 1/8 in. opening at base

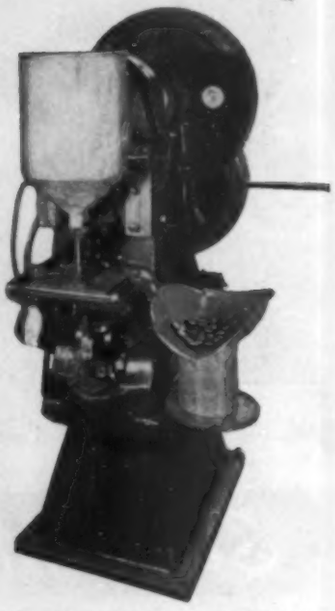
GET DUREZ 1900 ... and get all 3

High Gloss... High Impact Strength... Easier Preforming!

Heavy duty terminal box for industrial use molded of Durez 1900. Here rugged strength combines with smooth finish and good gloss.



Durez 1900, showing new particle size and preformed pellets. These particles feed into hopper easily, requiring no special handling. (Patents pending on molding compounds of this type.)



Typical preforming machine, indicating how Durez 1900 can be handled quickly and easily on conventional preforming equipment.

DUE TO THE long fibre fillers required to make high impact plastics, they have always been difficult to preform. Nor have they ever given wholly satisfactory, smooth, glossy finishes. But those "headaches" are now history! In Durez 1900 you get a high impact material that is far easier to preform than other high impact molding compounds—and one that molds with a remarkably smooth, glossy finish.

This unique combination makes Durez 1900 ideal for heavy duty moldings where maximum durability and attractive appearance are essential. Moreover, the molding properties of the compound are outstanding. Due to its unusual new particle size, Durez 1900 flows through preforming hoppers and into dies easily. This new particle size also cuts dust loss a good 50 per cent!

With Durez 1900, you can now take the tougher high impact jobs in your stride. This is one more example of how Durez leads in developing new materials to lick hard plastics problems. Write for complete information and samples.

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PLASTICS THAT FIT THE JOB

Permanence of the physical properties of plastics*

by J. DELMONTE**

IN THE examination of the permanence of the physical properties of organic plastic materials, attention should be given to those operating conditions which are likely to produce changes in the materials. When these operating or service conditions have been analyzed, they should serve as the basis of comparison for the various plastics. As engineering materials, one of the most singular characteristics of organic plastics is their response to thermal influences. In fact, they are generally classified as thermoplastic or thermosetting, distinguishing between materials which are profoundly influenced by heat and those which are only slightly affected.

Another characteristic of plastics which has a decided influence upon the design and application of the materials, is their behavior under applied stresses. A review of technical literature indicates that with few exceptions, very few factual data useful for engineering purposes are available on the creep and cold-flow characteristics of the various plastics. Variations in test methods; examinations confined to one material; failure to stress the material for a sufficient length of time; and failure to report fully the nature of the molecular structure, composition, or previous history of the material, are some of the reasons detracting from the value of the research. Plastic materials, more so than many other materials of construction, are subject to permanent deformation under stress and, hence, require systematic analysis along these channels.

The media in which the plastic materials are operating may also have a bearing upon their properties. Particularly noteworthy are such influences as the actinic rays of sunlight, high humidity, and the corrosive effects of chemicals, any of which may cause a loss in utility of the material. When the material is to be used in a severe corrosive medium, tests in that specific medium under the most rigid operating conditions are usually conducted by the organization contemplating use of the material. Only in that manner can it be ascertained whether the material will prove acceptable.

Consequently, in examining the permanence of the physical properties of plastics, the following tests may be pursued to evaluate their relative merits.

1. Creep and cold-flow tests at various stresses and at various temperatures, for different lengths of time. Recovery upon removal of stress also to be observed.
2. Elevated temperatures:
   (*a*) Properties of plastics at high temperatures.
   (*b*) Properties of the plastics after return to room temperature; after exposures for different periods of time.
3. Immersion in water or high humidity (or in lieu of water, the use of corrosive chemicals).

Creep and cold-flow characteristics

In this paper, an analysis will be made of the creep and cold-flow characteristics of solid plastic materials, as they are available commercially, in sheet form. The need for data of this nature has been emphasized in recent years.[1,2] Standard compression and tension tests must be modified to take into consideration time and temperature, for organic plastics beside exhibiting elastic deformation exhibit a time-dependent plastic deformation. There has been some doubt as to when plastic deformation first begins to make its appearance, when the stress is slowly applied to the material. It has been suggested recently by R. Houwink that for solid organic plastics, every stress will produce a certain amount of plastic deformation.[3] The results of the present investigation show this to be the case for a number of plastic materials, even down to very low values of stress.

(*Please turn to next page*)

* Contributed by the Subdivision on Rubber and Plastics of the Process Industries Division for presentation at the Annual Meeting of The American Society of Mechanical Engineers, Philadelphia, Pa., December 6, 1939.

** Assistant to Chief Engineer of Research, Chicago Flexible Shaft Co.

1. Symposium on Consistency, American Society for Testing Materials Meeting of June 29, 1937, Philadelphia, published by the Society, 1938.
2. Permanence of Plastics, by G. M. Kline, Symposium on Plastics, pp. 35–51, American Society for Testing Materials Meeting of March 9, 1938, Philadelphia, published by the Society, 1938.
3. Second Report on Viscosity and Plasticity, Nordeman Publishing Co., New York, 1938, p. 220.

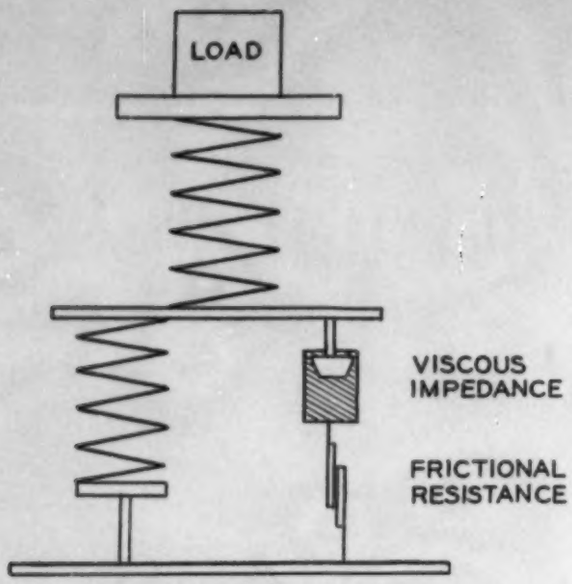


Fig. 1—Mechanical analogy of molecular structure of plastic material

A convenient mechanical analogy of the structure of a typical plastic material is given in Fig. 1, based in part upon conclusions arrived at in this paper. Under constant load, this mechanical analogy presupposes the following to take place:

1. Upon placing the material under stress, there follows immediately a very rapid elastic deformation.

2. This is followed by a plastic deformation which depends upon the stress, temperature, and the time of application of the stress.

3. Under the continued application of load, the velocity of this plastic deformation will change with time. The internal structural elements contributing to this deformation characteristic are depicted in the mechanical analogy as possessing internal friction (as sliding friction between adjacent long chain molecules), and as possessing an inertia effect, depending upon the rate of change of deformation velocity (illustrated as a dashpot and cylinder).

4. Upon removal of the load, there is a rapid, immediate elastic recovery, followed by a relaxation period in which further recovery from deformation occurs, depending upon the manner in which the material was stressed.

5. Another condition, not apparent from the mechanical analogy of the internal structure, admits the possibility that the elastic structure can be deformed past its elastic limit, beside the plastic deformation exhibited by those elements not part of the main elastic structure of the material.

The majority of these conditions has been recognized in previous studies.[3,4] A mechanical analogy for plastic materials employing the same elements, shown in Fig. 1, has also been suggested,[5] though in an entirely different arrangement.

It is not entirely unexpected that new interpretations are necessary for such constants as elastic limit, yield value, proportional limit, and modulus of elasticity for materials possessing an internal structure capable of elastic and plastic deformation. Most stress formulas for beams and other structural members are developed for materials operating strictly upon the elastic portion of their stress-strain characteristics. It is obvious that these formulas must be modified when the permanency of the physical properties is a function of the material, its temperature, and time duration of stress. The creep and cold-flow data disclosed in this paper have been confined to a study of the influence of time under constant temperature conditions. Further studies are in progress to examine systematically the effects of temperature.

Researches in plastic deformation

Method. Many of the researches upon the plastic deformation of amorphous materials have employed methods designed to give uniform tensile or compressive stresses within the test materials, under uniform loading conditions. For example, some tests compare plastic materials on the basis of percent change in height of a small cube of specimen under a predetermined load at 120 deg. F., over a period of 24 hrs.[6,7] This technique is also employed in the mechanical testing of rubber, where dead weights are applied for certain periods of time on rubber samples.[8,9] Other methods quite commonly employ ball-and-needle penetrometer techniques under certain loads at certain temperatures, for various time intervals. It has been the author's experience that such methods are particularly adaptable to materials which exhibit relatively large deformation for a given tensile or compressive stress. These materials would include those plastics which have been described as possessing rubber-like qualities such as plasticized polyvinyl acetals, plasticized polyvinyl chlorides, rubber-like alkyds, certain acrylic resins, etc. For example, under a constant tensile stress of 41 lb. per sq. in. at 85 deg. F., the time-deformation characteristics of polyvinyl butyral are shown in Fig. 2. This material has also been examined for changes in its photoelastic qualities under similar test conditions.[10] However, when the more solid materials of this investigation were examined under direct tension and compression, the time for appreciable plastic deformation to take place was very long, lessening the accuracy of the readings, and making it difficult to distinguish the various stages of plastic deformation.

Another procedure followed in observing creep phenomena is to load and unload materials within the pro-

4. Elasticity, Plasticity, and Structure of Matter, by R. Houwink, Cambridge University Press, 1937.

5. Ionic Mobility in Solid Dielectrics, by A. Gemant, Journal of Applied Physics, *10*, July, 1939, pp. 508–513.

6. Cold Flow of Insulating Materials, by R. Burns and I. L. Hopkins, Modern Plastics, *14*, August, 1937, pp. 42 and 69–71.

7. Physical Properties of Natural and Synthetic Materials, by R. Houwink, Akademische Verlagsgesellschaft, Leipzig, 1934, chapter 3.

8. A Simplified Goodrich Plastometer, by E. Karrer, J. M. Davies, and E. O. Dieterich, Industrial and Engineering Chemistry, Analytical Edition, 2, 1930, pp. 96–99.

9. The Plasticity of Rubber and Its Measurements, by I. Williams, Industrial and Engineering Chemistry, *16*, 1924, pp. 362–364.

10. Double Refraction and Change in Length of Plastics, by H. W. Farwell, Journal of Applied Physics, *10*, February, 1939, pp. 109–113.

portional limit of the stress-strain curve,[11,11a] measuring the creep as a function of the elastic-hysteresis loop. Of course this technique is important also in determining Poisson's ratio. However, this method does not permit a study of the effects of time duration of stress which is so highly important to plastic deformation, and is not readily adapted to the study of recovery phenomena, such as the elastic aftereffect.

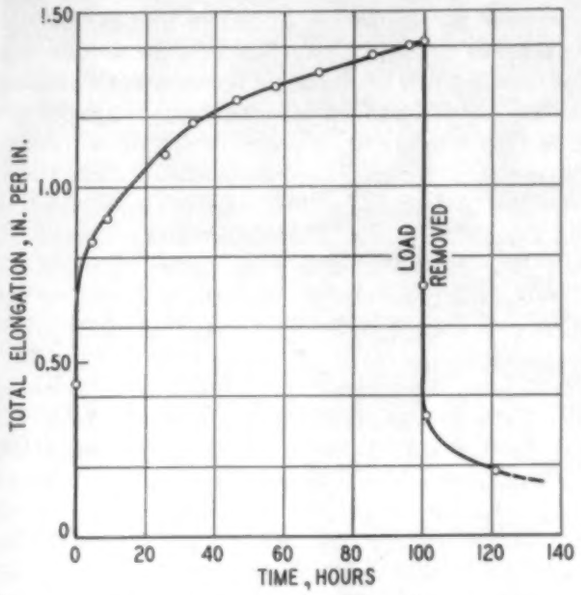


Fig. 2—Time-deflection curve for polyvinyl butyral

In this investigation samples of the plastic materials were supported as simple cantilever beams and loaded by dead weights at the end, Fig. 3. The apparatus designed by the writer tested four samples simultaneously, making it possible to observe materials under four different maximum fiber stresses during the same period of time. The equipment was enclosed within an insulated chamber, thermostatically controlled with air circulation, to 85 deg. F. plus or minus 2 deg. F. Four micrometers attached solidly to the support block measured the end deflection of the specimens by electrical contact with the support for the weights, and completing the circuit with a 7.5 w. lamp placed in series. The micrometers were operated manually when readings were to be taken. The load applied by spring-actuated dial gages was too great to permit using them in these tests. The supports for the weights were reduced to a minimum, weighing only 4 grams. The micrometers were read when contact was made with the weight support, which was indicated by the lighting of the lamp. The readings were accurate to plus or minus 0.0003 inch. The specimens were retained at their ends by $^1/_8$-in. steel pieces, clamped down by two thumb screws. In making stress calculations, the weights of the supports for the loads and the weight of the specimens were taken into consideration. Electrical connection to the weight supports was made through a fine, B.S. No. 34 enameled wire.

While the values of deformation observed are in fact an integrated value for all stresses up to the maximum fiber stress, a simple cantilever beam affords a simple method of ascertaining the elastic and plastic properties of materials. The simple cantilever beam has an advantage over other types of beams, inasmuch as its moment diagram for loads at the end is a straight-line function of the suspended length, and also possesses a uniform shear diagram. It may be readily seen that the simple cantilever beam by reason of its deflection at the end, acts as an amplifier of stress deformation in its fibers, in a ratio of some function of the length to the thickness of the material. There are many precedents for the use of a deflection of a beam as a measure of flow in solid bodies.[12,13,14,15] Trouton investigated flow in rods of pitch under the methods of tension, compression, and bending. His curves for sagging as a function of time show a distinct exponential relationship. In a majority of these earlier instances, tests were conducted upon bituminous substances or concrete, whereby the test specimens were placed upon two horizontal supports and deflection observed in the middle under the weight of the specimen or under additional weights.

The deflection of a beam also serves as the basis of comparison for plastic materials in a heat-distortion test in an American Society for Testing Materials specification[16] where the temperature is raised slowly and the temperature noted at which a deflection of 10 mils occurs. In a similar British test specification, a

11. The Stress-Strain Relation in Textile Fibers, by R. L. Steinberger, Physics, *5*, February, 1934, pp. 53–60.

11a. Effect of Temperature on Physical and Optical Properties of Photoelastic Materials, by G. H. Lee, and C. W. Armstrong, Journal of Applied Mechanics, Trans. A.S.M.E., *60*, 1938, p. A-11 and errata, p. A-85.

12. On the Coefficient of Viscous Traction and Its Relation to That of Viscosity, by F. T. Trouton, Proceedings of the Royal Society of London, series A, *77*, 1906, pp. 426–440.

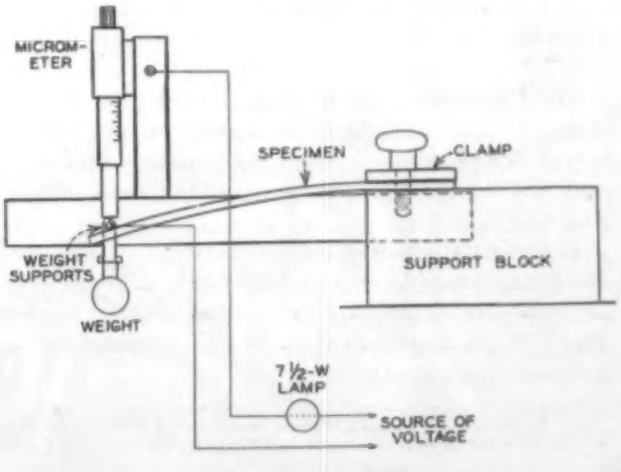
13. The Rheological Properties of Cement and Cement-Mortar-Stone, by E. C. Bingham and M. Reiner, Physics, *4*, March, 1933, pp. 88–96.

14. Determinations Regarding the Plastic Properties of Asphaltic Bitumen, by R. N. J. Saal, Proceedings World Petroleum Congress, *II*, London, 1933, pp. 515–523.

15. Rate of Deformation of Loaded Bar, by H. Deutler, Physikalische Zeitschrift, *33*, March 15, 1932, pp. 247–259.

16. Standard Methods of Testing Molded Materials Used for Electrical Insulation, American Society for Testing Materials, Philadelphia, Supplement to Book of A.S.T.M. Standards D 48–37, 1937, pp. 232–240.

Fig. 3—Schematic diagram of test apparatus



simple cantilever test beam is employed to determine what is referred to as "plastic yield." The plastic yield is described as the specified allowable maximum deflection for a 5 by 5-mm. specimen, 150 mm. long, at a certain temperature.[17]

Materials Tested. The following materials were included in this investigation and a comparison made of their relative deformation as a function of time, for various stresses induced in the materials when they were loaded as simple cantilever beams. The specimen lengths were selected at 5 in., with the exception of polystyrene, which was 2.5 in. long. The results for polystyrene were corrected to a 5-in. length. The widths of the specimens were approximately 1 in. and, while an effort was made to obtain uniform thickness, the laminated phenolic and polystyrene samples differed from the others.

Cellulose acetate sheet: Specimens were cut from clear transparent sheet stock, approximately 0.089 in. thick; obtained from Fiberloid Corp. (now Monsanto Chemical Company).

Polyvinyl chloride acetate: Specimens cut from a white, filled stock, 0.094-in. thick; obtained from Carbon and Carbide Chemicals Corp., series V.

Methyl methacrylate: Specimens were cut from clear, transparent stock 0.09-in. thick; material obtained from Röhm and Haas Company.

Polystyrene: A flat injection-molded test bar 0.069-in. thick served as a test sample; obtained from Dow Chemical Company.

Laminated phenolic sheet, canvas base: Standard N.E.M.A. grade L material, 0.065-in. thick, employed.

Theory. Within certain stresses, the initial rapid deflection of the simple cantilever-beam test specimens is a truly elastic deformation, the magnitude of the deflection and the maximum fiber stresses being calculable from the following well-known formulas, which assume validity of Hooke's law and uniform distribution of stress-strain relations in compression and tension about the neutral axis

$$y_e(\text{max.}) = W L^3/3 E I \quad [1]$$

and

$$M = S I/c \quad [2]$$

where y_e = true elastic deflection
W = weight supported at end of beam
L = distance from point of support to weight
E = modulus of elasticity
I = moment of inertia
S = maximum fiber stress
M = maximum bending moment = $W \times L$
c = distance from axis to outermost fiber

Immediately following the truly elastic deformation, the phenomena of creep and cold flow will commence, increasing the amount of deflection. There are two stages of plastic deformation which were observed for the materials under test:

Stage *A*—rate of change of deformation with time (dy/dl) changes from a maximum to a minimum constant rate.

Stage *B*—in which dy/dl remains constant for an indefinite time for a given fiber stress (or given integrated stress value).

Unlike crystalline materials which may work harden, whereby dy/dl approaches zero, none of the plastics included in this test behaved that way, even at maximum fiber stresses as low as 500 lb. per sq. in. For the sake of definition, *cold flow* may be described as that constant rate of change of deformation with time, which a material will exhibit after being subjected to a certain stress for a certain period of time, at a constant temperature. In accordance with earlier suggestions,[3] *creep* may be described as that stage of plastic deformation where the velocity of the deformation rate changes with time (d^2y/dl^2). Creep experiences its greatest value following the elastic deformation, becoming zero when true cold flow finally occurs. From the data presented in this paper, it will be seen that considerable time elapses before creep becomes zero, depending upon the maximum initial fiber stress. In general, it was observed that the lower the maximum fiber stress, the sooner creep was ended and pure cold flow began.

The existence of plastic deformation as a separate phenomenon from elastic deformation is brought out in the mechanical analogy given in Fig. 1. This admits the possibility that part of the stress is carried by nonelastic elements, which may also be in parallel with some of the elastic elements. This last consideration is borne out when one considers that the elastic aftereffect upon removal of load derives its energy from an elastic structure which is retarded in its recovery by the plastic elements.

A general expression for plastic deformation may be developed in the light of creep and cold-flow phenomena. Assuming the two stages of deformation for amorphous materials, we have the following

$$y(\text{total}) = y_e + y_p \quad [3]$$

where y_e = elastic deformation
y_p = plastic deformation

The elastic deformation is defined by Hooke's law within the elastic limit of the material:

$$y_e = S/C \quad [4]$$

where C = elastic constant
S = stress required to produce y_e

Expressing y_p as a function of time and stress, the following formula may be applied

$$S = RV + M\frac{dV}{dt} \quad [5]$$

where

$$V = dy_p/dt \quad [6]$$

and M = coefficient of viscous impedance
R = coefficient of internal resistance of molecules

(*Please turn to page 78*)

17. Synthetic Resin Phenolic Molding Materials and Moldings, Specification No. 771, British Standards Institution, London, 1938.

Plastics at the A. C. S. meeting

THE Organic Plastics Group of the Division of Paint and Varnish Chemistry of the American Chemical Society met in Cincinnati on April 9 to hear and discuss a group of papers in which the emphasis was primarily on the theoretical aspects of the chemistry of plastics. Nine papers were presented at the general session in the morning. A Symposium on Cellulose Plastics, held jointly with the Division of Cellulose Chemistry and comprising four papers by outstanding chemists in this field, featured the afternoon meeting. Titles, authors, and abstracts of these various papers are presented herewith.

THE STRUCTURE OF VINYL POLYMERS. CATALYSTS. C. S. Marvel and E. H. Riddle. Polymerization of vinyl acetate, methyl alpha-bromoacrylate, and vinyl bromide was studied with three catalysts: benzoyl peroxide, boron trifluoride, and ultraviolet light. In general, polymers of the same structure were obtained, although boron trifluoride yields an insoluble polymer of vinyl acetate, attributed to secondary cross-linking. The structure of the monomer is deemed to be the prime factor in determining the arrangement of the recurring units in the polymer.

DIPOLE ROTATION IN HIGH POLYMERS. R. M. Fuoss. The electrical characteristics of systems involving polyvinyl chloride, polystyrene, and polypara-chlorostyrene, and various plasticizers were studied over a wide range of frequency and temperature. The results are interpreted on the basis of the behavior of dipoles.

MOLECULAR WEIGHTS OF ORGANIC HIGH POLYMERS. E. O. Kraemer. Recent work on the determination of the molecular weights of organic high polymers and their heterogeneity is critically reviewed.

VISCOSITIES OF POLYESTER SOLUTIONS AND THE STAUDINGER EQUATION. P. J. Flory and P. B. Stickney. A series of decamethylene adipate polyesters was prepared, and their number and weight average molecular weights were accurately determined by a new method based on the viscosity of the molten polyester. The results indicate that a weight average molecular weight should be used in Staudinger's equation for relatively low molecular weight, non-uniform polymers rather than the customary number average molecular weight.

SOME OBSERVATIONS REGARDING THE HARDNESS OF THERMOPLASTICS. W. F. Bartoe. Data are presented correlating the penetration resistance, abrasion resistance, and softening temperature range of methyl methacrylate plastic.

UREA - FORMALDEHYDE FILM-FORMING COMPOSITIONS. IV. AIR-DRYING FILMS BY ACIDIC CATALYZATION. T. S. Hodgins and A. G. Hovey. Air-drying or fast forced drying at temperatures not exceeding 140 deg. F. is achieved with accelerators consisting principally of inorganic acid esters of alcohols of 4 or more carbon atoms. The latter imparts solubility while the partially esterified acid component maintains a low pH which makes fast gelation possible. Chemical plasticizers may be used, but alkyd resins are preferred because they also impart adhesion and durability.

LACTIC ACID AS A COMPONENT OF SYNTHETIC RESINS. J. T. Stearn, B. Makower, and P. H. Groggins. Glycerol dilactate, which possesses the same number of hydroxyl groups as glycerol itself, was condensed with phthalic and maleic anhydrides, and azelaic and sebacic acids. Electrical and physical properties of the reaction products are reported. Investigation of the conversion of lactic acid to acrylate resins indicated that it is doubtful whether this process can compete favorably with syntheses based on the use of either ethylene or ethylene oxide.

A SIMPLIFIED DISTINCTNESS-OF-IMAGE GLOSSMETER AND SOME OF ITS APPLICATIONS. R. J. Meyers. An instrument is described for recording and evaluating by means of numerical indices the relative gloss of coatings and plastics.

MEASUREMENT OF GLOSS. L. A. Wetlaufer. Various factors which must be considered in the measurement of gloss and in preparing films for such examination are discussed.

Symposium on cellulose plastics
W. I. Patnode, presiding

CELLULOSE DERIVATIVES AS BASIC MATERIALS FOR PLASTICS. E. Ott. The historic, economic, and technical significance of cellulose derivatives to the plastics industry is surveyed. The long-chain cellulose molecule imparts toughness and flexibility, and solubility, compatibility with plasticizers, softening point, and moisture absorption may be controlled by the nature and amount of substituent groups introduced into the cellulose molecule. The development of solvents and plasticizers is also shown to be intimately associated with the history and growth of the cellulose derivatives. (*Please turn to page 82*)

Properties and performance of plastic bearing materials*

by L. M. TICHVINSKY**

Bearings made of plastic materials can be used successfully not only for the case of perfect fluid lubrication but also for that of semifluid lubrication. Certain additions, such as graphite, will sometimes permit the application of these materials under conditions of dry friction.

By virtue of good physical properties these bearings find a wide application. Heavy-duty plastic bearings are used in the steel-mill industry. Lubricated and cooled with water, they carry heavy loads at pressures of several thousand pounds per square inch. As guide bearings their performance ranges from small, high-speed spindles, to large ship-propeller shafts. Oil-, water- and grease-lubricated plastic bearings are used extensively in industrial, marine and farm machinery.

There are many differences in the behavior of plastic and metal bearing materials by virtue of which the performance is also different. This article intends to point out important physical properties, as well as some of the characteristic performances of plastic bearing materials.

THERE are many reasons for the increase in the use and application of various kinds of bearing materials bonded with synthetic resin. The industry in this country became interested in these materials mainly because of some qualities superior for certain applications to those found in bearing metals and alloys. An extensive development and application of plastic bearing materials abroad was and is due primarily to the lack of basic bearing metals.

This article describes the bearing materials bonded with synthetic resin. Rather complete data are given on the laminated materials, including physical properties as well as the results of various bearing performance tests. This information was gathered from various domestic and foreign technical and scientific publications, as well as from testing in the author's laboratory.

Types of synthetic resin-bonded bearing materials

All bearing materials bonded with synthetic resin can be divided into three types in accordance with their internal structure.

(1) The bearings of the first type are made from various plain or graphitic molding powders. Numerous kinds of bearings for light and medium load applications are made from these materials. Guide bushings for high-speed spindles, or gland materials for sealing purposes, are typical examples of the use of this material; these bearings perform under all types of friction, namely, dry, boundary and fluid. The application of these materials is rather limited because, as they are very brittle and fragile, impacts of even small magnitude may cause failure. Those made of graphite powder have a rather high heat-transfer coefficient.

(2) The second type comprises the most important and widely used bearings. Such bearing material is obtained by molding at high pressure and temperature sheets of woven textile fabric treated with an organic binder. Synthetic resin of the phenol-formaldehyde type is usually used in the manufacture of laminated bearing materials. The molding is done in hydraulic presses (pressure varies from 1200 up to 2200 psi) at temperatures ranging from 120 to 180 deg. C.[1] Under combined action of heat and pressure the resin softens or melts and undergoes a further chemical reaction, resulting in a material which no longer is fusible. By this action the filler (cuttings, laminations and the like) is permanently bound. The desired thickness for the final product determines the duration of this operation. It may last from 10 minutes to 30 hours.

Laminated bearing material is strong and tough. Bearings made of such materials perform efficiently when lubricated with water in which case the latter serves as lubricant and as a cooling agent. Almost any liquid (except strong alkalies) can be used, and although it might be recommended sometimes to add a lubricant, e.g., tallow or suitable emulsion, to the water, these bearings do not require oil or grease.[2]

(3) Bearing material of the third type is based on an internal felt-like structure. It is obtained by impregnating a felt of fibrous fillers consisting of cellulose fluff, linters and similar materials. The resin is generally precipitated from a thin aqueous solution (sodium hydroxide) on and in the felt-forming fibers.

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* Based on a paper which was presented at the Annual Meeting of The American Society of Mechanical Engineers, Philadelphia, Pa., December 4–8, 1939.

** Research Laboratories, Westinghouse Electric & Manufacturing Co.

1. Werkstoffe für Gleitlager, by A. Thump and R. Strohauer. R. Kühnel, Julius Springer, Berlin, 1939, pp. 119–171.

2. Properties and Performance of Bearing Materials Bonded with Synthetic Resin, by G. R. Eyssen, in General Discussion on Lubrication and Lubricants, The Institution of Mechanical Engineers, London, October 1937. American edition published by The American Society of Mechanical Engineers, New York, *1*, 1938, group 1, pp. 84–92.

These materials range in their physical properties between the brittle powder moldings and the extremely tough and strong laminated materials.

Properties of synthetic resin-bonded materials

Laminated materials are the most important in bearing applications as already mentioned, therefore most of the information pertaining to the physical properties will be given in connection with these.

(*A*) *Modulus of Elasticity.* The modulus of elasticity, or Young's modulus, gives the relationship between stress and strain in the elastic region. It defines the amount of strain under load and, therefore, enables one to determine the deflection.

In connection with the materials in question, for a long time the value of the modulus of elasticity was found to be equal to 1.0 by 10^6 psi.[2] However, methods were devised through which the use of artificial silk, cotton and other fibers resulted in the increase of value of the modulus of elasticity up to 1.8 by 10^6 psi.[3]

Many of the synthetic bonded materials were developed in connection with their extensive use by the electrical industry. Through a change in the molding pressure alone it is possible to attain a considerable increase in the modulus of elasticity. This is clearly shown in Table 1.[4]

TABLE 1

Molding pressure, psi.....	2300	4600	9200
Modulus in tension, psi....	0.72×10^6	0.85×10^6	1.03×10^6
Modulus in bending, psi....	0.78×10^6	0.91×10^6	1.14×10^6

According to Riechers[4] the values of the modulus of elasticity for molded resinoid materials with various fillers are given in Table 2.

TABLE 2

Filler	Modulus, Psi
Wood flour.....	$(0.8 - 1.17) \times 10^6$
Organic textile.....	$(1.32 - 2.35) \times 10^6$
Organic filler.....	$(1.32 - 2.2) \times 10^6$

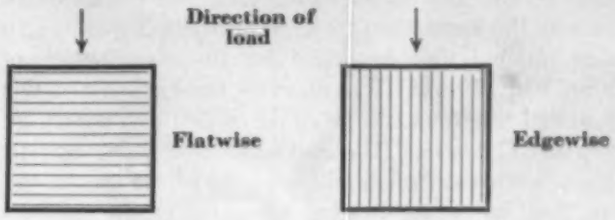
In the case of laminated tubing in which the fabric during rolling is maintained in tension, the modulus of elasticity reaches a value of about 3.0 by 10^6 psi.

(*B*) *Compressive Strength.* For bearing application the compressive strength of these materials is important. Compressive strength, as well as such properties as ultimate tensile strength and shear strength, can be increased by improved fabric filler as in Table 3.[3]

TABLE 3

Lb. per Sq. In.	Ordinary Fabric-filled Phenol Resin	Improved Fabric Filler
Compressive strength, psi.....	25,000	27,000
Ultimate tensile strength, psi...	11,000	27,000
Shear strength, psi.....	4,000–7,000	6,000–7,000

The compressive strength is usually given for laminated materials in two directions: right angle to laminae and parallel to laminae, as illustrated by the sketch below.



Data on the compressive strength of laminated materials in these two directions are given in Table 4.

TABLE 4

COMPRESSIVE STRENGTH OF LAMINATED MATERIALS

Flatwise, Psi	Edgewise, Psi	According to
40–45,000	20–24,000	Eyssen [2]
45–50,000	30–35,000	Rochester [7]
30–45,000	.....	Smyth [8]

(*C*) *Heat Conductivity.* In this property all synthetic resin-bonded materials are inferior to white bearing metals. However, some improvements in this property have to be mentioned, especially those achieved during the last year. About a year ago one could say roughly that bearing plastic materials showed a heat-conductivity coefficient which is 100 times smaller than that of a tin-base white metal (0.845 w. per sq. in. per deg. C. per in. for babbitt). By reason of improvements made it can now be said that this ratio has decreased about one half.

The thermal conductivity of ordinary phenolic laminate is taken as equal to 0.007 w. per sq. in. per deg. C. per in. Phenolic laminate for bearing application has higher thermal conductivity as in Table 5.

TABLE 5

Bearing Micarta I, w. per sq. in. per deg. C. per in.	0.0099 –0.01
Bearing Micarta II, w. per sq. in. per deg. C. per in.	0.00925–0.01

Eyssen's[2] published data vary between 0.0045 and 0.0059 w. per sq. in. per deg. C. per in. for laminated products, and between 0.0077 and 0.0089 w. per sq. in. per deg. C. per in. for moldable materials based on felts of impregnated nonoriented fibers. According to Richardson[5] the thermal conductivity of phenolic-plastic bearings is approximately 0.0072 w. per sq. in. per deg. C. per inch. Erk[6] gives a table of the thermal

3. "Filled" Resins and Aircraft Construction, by G. de Havilland, Journal of the Aeronautical Sciences, Aug. 1936; MODERN PLASTICS, March 1937.

4. Synthetic Resins in Aircraft Construction—Their Composition, Properties, Present State of Development and Application to Light Structures, by K. Riechers, National Advisory Committee for Aeronautics, Technical Memorandum No. 841, November 1937.

5. Heavy-Duty Bearings of Phenolic Plastics, by H. M. Richardson, in "General Discussion on Lubrication and Lubricants," I.M.E., London, October, 1937. American edition published by A.S.M.E., New York, *1*, 1938, group 1, pp. 249–259.

6. Wärmeleitfähigkeit von Kunstharzen, by S. Erk, "Kunst- und Presstoffe," *1*, V.D.I. Verlag, 1937, pp. 37–38.

conductivity of synthetic resins in "Kunstoffe and Presstoffe." In the phenol group there are some with thermal conductivity as high as 0.020, 0.021 and 0.023 w. per sq. in. per deg. C. per inch.

In an endeavor to increase the thermal conductivity and at the same time to improve friction qualities, a new method was developed for the manufacture of graphited *Micarta*. The thermal conductivity of this material was found to be equal to 0.015 w. per sq. in. per deg. C. per in. The heat conductivity of synthetic resin-bonded materials will never be of the same order as that for white bearing alloys. Certain developments in the methods of manufacture may still improve this property without impeding the others.

(*D*) *Other Properties.* The coefficient of expansion for the laminated product consisting of sheets of heavy square-woven duck bonded together by means of a synthetic resin of the phenol-formaldehyde type is 0.00002 per deg. C. per inch.[8]

The specific gravity of the synthetic resin-bonded materials varies between 1.25–1.40. For general calculation it can be assumed that 1 cu. in. weighs 0.05 lb. Oil absorption is negligible for practical purposes while water absorption was found to vary from 0.5–0.8 per cent when a test piece (2 by 2 by $^1/_2$ in.) was submerged in water for 24 hours.[2]

The Brinell hardness of synthetic resin-bonded materials was determined by Rochester[7] as 30–42, by Smyth[8] as 35–42.

Performance of synthetic resin-bonded bearings

The performance of all synthetic resin-bonded bearings is limited, as in the case of bearing metals and alloys, by the maximum allowable temperature of the bearing materials. The heat conductivity of the synthetic resin-bonded materials is lower than that of bearing metals. Therefore, such efficient cooling is required by which maximum amount of heat generated by friction can be removed by the circulating lubricant. An example of this is shown in Fig. 1. Such a bearing being lubricated and cooled with water performs at low speeds and medium loads. The sketch shows the arrangement of cooling and also the location of the high-pressure water inlet. This bearing is not operating in the boundary region at the starting and stopping

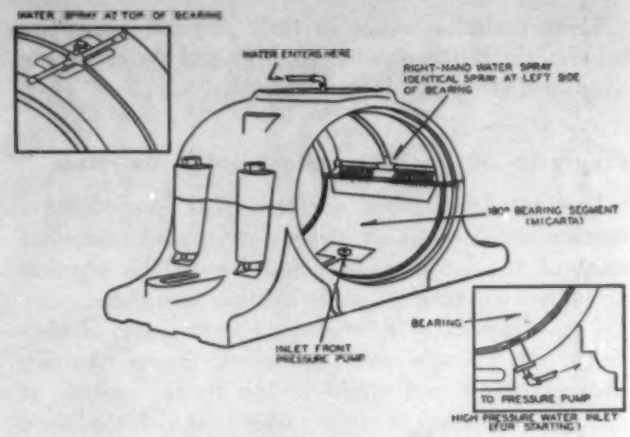

WATER SPRAY AT TOP OF BEARING
WATER ENTERS HERE
RIGHT-HAND WATER SPRAY IDENTICAL SPRAY AT LEFT SIDE OF BEARING
180° BEARING SEGMENT (MICARTA)
BEARING
INLET FRONT PRESSURE PUMP
TO PRESSURE PUMP
HIGH PRESSURE WATER INLET (FOR STARTING)

Fig. 1—Typical water-lubricated phenolic laminated bearing for ball and rod mills

periods because the high-pressure pump forces water into the bearing clearance.

The softening of the synthetic resin-bonded materials varies with type and grade of the bond. In this respect it is of interest to note some remarks by British authors pertaining to working temperatures of bearings. Smyth[8] indicated a safe working temperature of 100 deg. C. and an actual temperature of 150 deg. C. at which material is unaffected. Rochester[7] recommends a maximum working temperature of 60–80 deg. C. He mentions that maximum allowable running temperature for short periods might reach 250 deg. C. It is self-evident that high, localized temperatures might reach rather high values, not only in the region of dry or boundary friction, but even during perfect fluid lubrication.[9] In Table 6 data are given for a series of tests[10] during which the final bearing temperature and the values of the coefficient of friction

7. Fabric Bearings for Rolling Mills, by H. Rochester, in "General Discussion on Lubrication and Lubricants," I.M.E., London, October 1937. American edition published by A.S.M.E., New York, *1*, 1938, group 1, pp. 260–265.

8. Some Applications of Fabric Bearings, by Watson E. Smyth in "General Discussion on Lubrication and Lubricants," I.M.E., London, October 1937. American edition published by A.S.M.E., New York, *1*, 1938, group 1, pp. 277–284.

9. Physical Properties of Surfaces, III. The Surface Temperature of Sliding Metals, the Temperature of Lubricated Surfaces, by F. P. Bowden and K. E. W. Riddler, Proceedings of the Royal Society of London, series A, *154*, May 1, 1936, p. 640.

10. Versuche an Lagern mit Kunstharzbuchsen, by E. Heidebroek, Kunststoffe, 27, 263–267 (Oct. 1937).

TABLE 6

FINAL BEARING TEMPERATURE C. AND COEFFICIENT OF FRICTION MEASURED AFTER 2-HR.-20-MIN. RUNS
(According to Heidebroek)

Clearance Ratio,	Bearing Pressure = 22 Psi — Peripheral Velocity, Fps				Bearing Pressure = 155 Psi — Peripheral Velocity, Fps			
In. per In.	19.1	32.8	41.3	57.1	19.1	32.8	41.3	57.1
0.00153	55.0	65.0	71.0	....	55.0	67.0	75.0	....
	0.0183	0.0197	0.0206	....	0.0049	0.0049	0.0050	....
0.00175	51.5	60.5	66.5	78.0	55.0	65.5	74.5	85.0
	0.0206	0.0221	0.023	0.0226	0.0051	0.0051	0.0051	0.0051
0.0020	49.5	60.5	66.5	80.5	52.0	63.0	72.0	83.0
	0.0247	0.0267	0.0263	0.0278	0.0058	0.0060	0.0061	0.0062

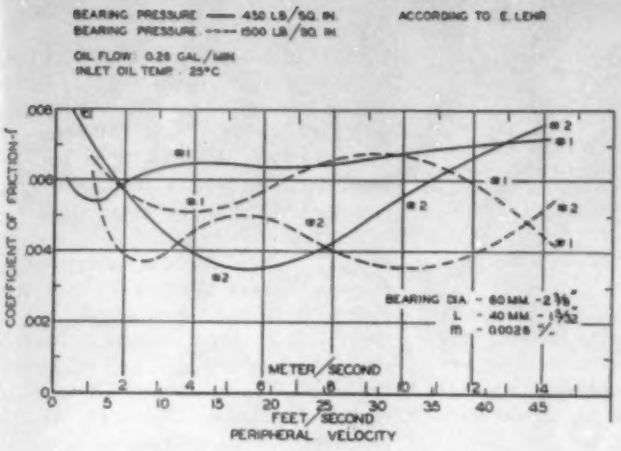

BEARING PRESSURE —— 450 LB/SQ. IN.
BEARING PRESSURE ---- 1500 LB/SQ. IN.
ACCORDING TO E. LEHR
OIL FLOW 0.26 GAL./MIN.
INLET OIL TEMP. 25°C
COEFFICIENT OF FRICTION-f
BEARING DIA - 60 MM - 2 3/8"
L - 40 MM - 1 9/32"
m - 0.0028 %
METER/SECOND
FEET/SECOND
PERIPHERAL VELOCITY

Fig. 2—Coefficient of friction as function of peripheral velocity at 450 and 1500 Psi pressure

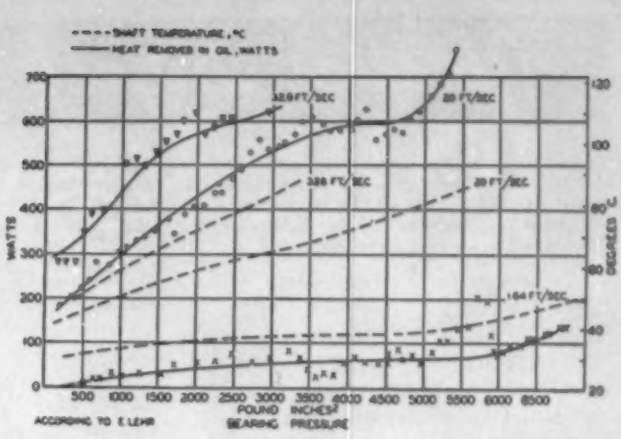
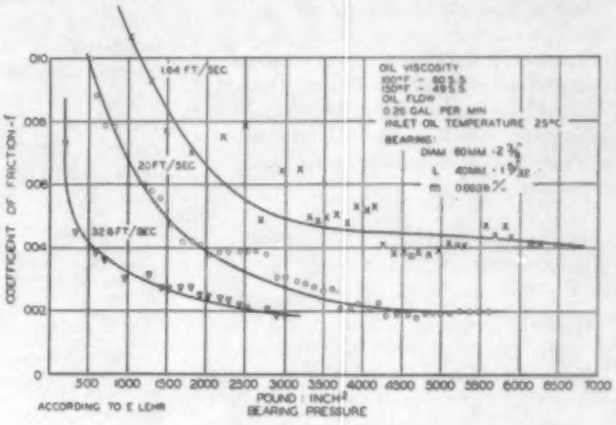


Fig. 3 (above)—Variation upon the bearing pressure and peripheral velocity of the coefficient of friction and Fig. 4 (below) of heat losses and shaft temperature



were measured as a function of peripheral velocity, clearance ratio and pressures of 22 and 155 psi. The bearing material was made of resin-impregnated cotton-cloth cuttings. A flow of light turbine oil varied between 0.238–0.715 gpm. The amount of circulating oil showed a tendency to increase with increasing clearance. Results of these tests indicate that the lower the bearing clearance ratio the higher is the running temperature, and the lower is the value of the coefficient of friction. For this reason it is advisable to provide the bearings with chamfered grooves, so that a large amount of lubricant may be admitted not only for lubricating purposes, but also for more efficient cooling. Another investigation was carried on during which the performance of various bearing materials was studied on a specially built test machine.[11] The values of the coefficient of friction of two materials are plotted on Fig. 2 as a function of peripheral velocity for pressures of 450 and 1500 psi. The bearing bushings were $3^3/_8$ in. diam., $1^5/_{32}$ in. long, and were machined with a 0.0028 in. per in. clearance ratio. A light oil having 80 Saybolt sec. at 100 deg. F. and 49 Saybolt sec. at 150 deg. F. was fed into the bearing housing at 25 deg. C. and a rate of 0.26 gpm. The two materials tested showed approximately the same performance, the values of the coefficient of friction being slightly higher for material No. 1 than for material No. 2. In Table 7 some of the characteristics of these materials are given.

TABLE 7

Material	Kind of Resin	Resin, Per Cent	Structure	Molding Time, Min.	Molding Temp., °C.	Additional Treatment
No. 1	Phenol	50	Cloth cuttings	45	165	10 hr. at 80° C.
No. 2	Phenol	45	Cloth cuttings	20	165	8 hr. at 125° C.

The performance of wound bushings impregnated by cresol is given in Figs. 3 and 4. The variation of the coefficient of friction with bearing pressure and peripheral velocity is given in Fig. 3, while the variation of the heat losses and shaft temperature with bearing pressure and peripheral velocity is given in Fig. 4.

These bearing tests were made at the same conditions as the tests of bearing materials given in Table 2. From Fig. 3 it is seen that the value of the coefficient of friction shows less variation at high loads at which it approaches some constant value. By diminishing the load, the values of the coefficient of friction rise rapidly. In the region of maximum pressures around 6000 psi the values of the friction coefficient lie between 0.002 and 0.005. More heat is being removed in the oil at higher peripheral velocities than at the lower, as can be seen in Fig. 4. It can also be noted that the slope of the shaft temperature is about the same as that of the heat losses. These shaft temperatures were recorded at steady-state conditions by means of a thermometer inserted in the journal hole specially drilled for this measurement.

All bearing surfaces must be well run in before optimum friction conditions are established. This is especially true for the case of bearings made of plastic material, where the running in must be done carefully and skillfully. It is found[1] that the best scheme for running in plastic bearings consists in loading the bearing gradually at low speeds until full load is reached and then bringing the journal (*Please turn to page 70*)

11. Versuche mit Pressstofflagern, by E. Lehr, Kunststoffe, *28*, 161–170 (July 1938).

Plastics Digest

This digest includes each month the more important articles (wherever published) which are of interest to those who make plastic materials or use them. Requests for copies of the magazines mentioned should be directed to the individual publishers whose addresses will be mailed upon receipt of a self-addressed stamped envelope.

General

STANDARD OIL "RUBBER." Business Week, April 13, 1940, pp. 51–2. Standard Oil Development Co. plans to erect a Buna plant of 10,000-lb. daily capacity in Baton Rouge in cooperation with Standard of Louisiana. Butadiene will be made from butane, a 7-billion-lb. by-product of modern refinery operation, mixed with acrylo-nitrile, and polymerized to form Buna rubber. The potential bottleneck in the production of man-made rubbers, which include Dow's Thiokol du Pont's neoprene, Goodrich's Koroseal, and Standard's Buna, is not equipment, but trained chemists to supervise the syntheses.

SELF - LUMINOUS MATERIALS AND THEIR UTILIZATION. L. Levy and D. W. West. Chem. Age (London) *42*, 169–72 (Mar. 23, 1940). The properties of sulfide phosphors and their applications in air raid protection work are discussed. Reference is made to British Standards Institution specification BS/ARP/18 for control of quality of these fluorescent and phosphorescent materials.

HISTORICAL AND SCIENTIFIC REVIEW OF PLASTICS. L. Frossard. Memoires Soc. Ing. Civils *92*, 287–303 (Mar. 1939). The author emphasizes the recent trend toward fundamental research on the chemical constitution of polymers as a basis for factory production of desirable new products, and the considerable backing in resources and personnel that are required for such work. He notes that 36 pupils were associated with Staudinger during the period 1930 to 1934 in his work on high polymeric compounds, and that during the period 1931 to 1937 the names of 22 chemists were attached to the chloroprene patents of E. I. du Pont de Nemours and Co. and 27 chemists to the polybutadiene patents of the I. G. Farbenindustrie.

Materials and Manufacture

NEW PROCESS FOR SYNTHETIC HORN PRODUCTION. Werner Lück. Kunststoffe *30*, 72–4 (Mar. 1940). Experimental work on the problem of simplifying the manufacture of casein plastic and improving the properties of the finished product is described. The new process is claimed to have resulted in acceleration of the hardening reaction, prevention of porosity, combination of plastifying and hardening actions, and production of transparent and waterproof casein plastics. The various reagents used for hardening, plastifying, and clarifying purposes are tabulated.

DIELECTRIC CHARACTERISTICS OF A CHEMICALLY PURE SYNTHETIC RESIN. C. G. Garton. J. Inst. Elec. Eng. *85*, 625–38 (Nov. 1939). Measurements and theoretical equations of the temperature variation of the dielectric constant, loss angle, and conductivity of a pure glyceryl-phthalate resin are reported. The effects of known amounts of impurity are considered. It is concluded that the practical advantages of a pure resin as compared with one containing 2 to 3 percent impurity are negligible for most purposes.

Molding and Fabricating

EXTRUSION OF PLASTIC THERMOSETTING COMPOUNDS. Plastics *4*, 53–4 (Mar. 1940). The extrusion method fills the gap between molding in closed dies and the shaping of articles on turning lathes. The commercial applications which have been made of phenolic extrusions include kettle handles, table-edge beading, towel rails, curtain runners, lamp standards, walking sticks, torch cases, duplicating machine rollers, and door handles.

MOLDS WITHOUT CHROMIUM PLATE. T. V. Trofimova and L. A. Makarova. Promyshlennost Organicheskoi Khimii *6*, 681 (Dec. 1939). The function of chromium plate on molds for phenolic resin compounds is to prevent the slight acid corrosion which causes the article to stick to an unplated mold. Tests with Bakelite, Durez, and a Russian product show that proper compounding with lime prevents corrosion, thus permitting the use of molds which are not chromium plated while retaining the desirable physical and electrical properties of the material.
(Translation available from Hooker Scientific Library, Central College, Fayette, Mo.)

HOBBING MOLDS IN THE G. E. PLASTICS DEPT. C. O. Herb. Mach. *46*, 87–91 (Feb. 1940). A discussion of how molds are made by hobbing, the types of steels used for the hobs and molds, and the heat treatment of the molds after hobbing.

Applications

INFLUENCE OF PRESSING CONDITIONS, RESIN CONTENT, AND ARRANGEMENT OF REINFORCING SHEETS ON THE PROPERTIES OF LAMINATES. W. Küch. Zeit. Vereines Deut. Ing. *83*, 1309–16 (Dec. 30, 1939). Experimental data are reported on the influence of various factors on the static strength, impact strength, and moisture resistance of laminated plastics made with paper, fabric, and wood veneers. These results indicate that by the use of suitable reinforcing media, resins, and fabricating technique, the mechanical strength of laminated plastics suitable for aircraft and other structural applications can be appreciably increased.

SYNTHETIC LINOLEUM. E. A. Bauman. Promyshlennost Organicheskoi Khimii *6*, 671 (Dec. 1939). Vinyl chloride resin has been successfully compounded to yield flexible plastics which are superior to drying oils for making linoleum. With tricresyl phosphate as plasticizer, a fireproof linoleum is obtained. Resistance to aging is said to be excellent. Manufacturing economies help to compensate higher cost of materials, since such operations as oxidizing the oil, drying the linoxyn, and curing the product are eliminated.
(Translation available from Hooker Scientific Library, Central College, Fayette, Mo.)

SUPERPRESSED PLYWOOD. R. K. Bernhard, T. D. Perry, and E. G. Stern. Mech. Eng. *62*, 189–95 (Mar. 1940). The strength of plywood prepared at pressures up to 1500 lb. per sq. in. increases in direct proportion to its density. Thin veneers ($^1/_{28}$ in. thick) gave stronger bonds than veneers of $^1/_8$-in. thickness. Other variables, such as species of wood, amount of resin, number of cross layers, and pressures from 200 to 1500 lb. are considered in this detailed report of experimental work.

Testing and Properties

BURST TEST DATA ON LAMINATED GLASS. W. R. Koch and E. J. Wyrostek. ASTM Bulletin, Mar. 1940, pp. 21–25. The use of pressure cabins in aircraft for substratosphere flying has necessitated a study of the physical properties of laminated glass over a wide range of temperatures. The plastics used in the laminated glass specimens included cellulose acetate, and acrylate and vinyl resins. All types of laminated glass were found to have higher burst pressures at temperatures near −30 deg. C. than at about 20 deg. C. Some specimens under constant pressure fractured after a few minutes at a pressure one-third of that necessary in burst tests conducted under regularly increasing pressures. The former test is more significant in so far as actual use in aircraft is concerned.

Woven Tenite

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• • •

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U. S. Plastics Patents

Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 10 cents each

MATCH HEAD. A. B. Doran (to H. R. MacMillan). U. S. 2,193,124, March 12. Use of an alkyd resin binder in non-hygroscopic match heads.

JOINING PLASTICS. G. A. Tinnerman (to Tinnerman Products, Inc.). U. S. 2,193,306, March 12. Forming thin hardened plastic parts with a connecting boss and a clip device for joining adjacent parts.

VARNISH RESIN. F. Blass, P. Heisel, A. Hendschel and O. Nicodemus (to I. G. Farb. Akt.). U. S. 2,193,327, March 12. Resins which can be boiled in linseed oil are formed by hydrogenating saturated aliphatic hydrocarbons having at least 3 phenylol substituents.

MOLDING MACHINE. Chas. S. Dewey, Jr. U. S. 2,193,395, March 12. In a plastic molding machine a number of die units on a work table are automatically brought successively into registry with a high pressure ram which closes the die members, and after having been closed by the high pressure ram each die unit is held in closed position by an auxiliary ram.

DISHED ARTICLE. C. H. Hempel, E. C. Schreihart and P. N. Clemens (to Heresite and Chemical Co.). U. S. 2,193,513, March 12. Forming the bottom and sides of a dished article from laminated plastic-impregnated material, and the corners from a plastic composition, and molding the entire assembly in one piece.

PLASTICS IN COLORS. V. Fischett (to National Fabricating Co.). U. S. 2,193,586, March 12. Articles in contrasting colors, such as numeral buttons, are molded by forming a recessed plastic article, filling the recess with plastic of a different color, solidifying and trimming.

PLASTICIZED RESINS. C. H. Alexander (to B. F. Goodrich Co.). U. S. 2,193,613–4 and 2,193,662, March 12. Plasticizing gamma polyvinyl chloride with alkyl or cycloalkyl naphthalenes or naphthyl halides or naphthyl ethers, or with the corresponding derivatives of diphenyl; and adding an alkoxyalkyl ester of a fatty acid.

RESINIFICATION ACCELERATOR. D. E. Cordier (to Plaskon Co.). U. S. 2,193,621, March 12. Use of carbamazide as a latent accelerator in thermosetting urea resins.

ADHESIVE HARDENER. A. M. Howald (to Plaskon Co., Inc.). U. S. 2,193,630, March 12. Use of a dry mixture of two ammonium salts, one of a strong and one of a weak acid, for hardening urea resin adhesives.

COATED PLASTER. A. E. Marshall (to Plaskon Co., Inc.). U. S. 2,193,635, March 12. Forming a layer of high tensile strength gypsum plaster in a mold, covering with a thermosetting resin and hot pressing to form the resin into a waterproof enamel-like film.

MOLD LUBRICANT. M. H. Bigelow (to Plaskon Co.). U. S. 2,193,670, March 12. Use of cadmium soap (stearate or palmitate) as lubricant for urea resin molding compositions.

SPECTACLE LENS. O. Röhm and W. Bauer (to Röhm and Haas Co.). U. S. 2,193,742, March 12. Making eyeglass lenses of polymethacrylate resins.

INJECTION MOLDING. L. L. Berry (to Erie Resistor Corp.). U. S. 2,193,787, March 19. An improved machine for die-casting plastics by injection under pressure, especially for casting frames on fragile inserts.

HYDROCARBON RESIN. I. V. Wilson (to Monsanto Chemical Co.). U. S. 2,193,792, March 19. Raising the melting point of naphtha-soluble petroleum resins, without sacrificing solubility, by effecting the catalytic resinification in presence of a coal-tar product.

RESIN BOND. F. Seebach (to Bakelite Corp.). U. S. 2,193,941, March 19. Bonding a ply of material to a base by an interposed layer of heat-hardenable phenol-aldehyde resin.

SAFETY GLASS. B. J. Dennison (to Pittsburgh Plate Glass Co.). U. S. 2,194,013, March 19. The thermoplastic interlayer in safety glass is plasticized with esters formed from mixed coconut oil acids and a glycol or glycol ether.

ACETAL RESINS. Wm. O. Kenyon and T. F. Murray, Jr. (to Eastman Kodak Co.). U. S. 2,194,205, March 19. Stabilizing polyvinyl acetal resins by partial hydroylsis or alcoholysis of components tending to make the resin unstable.

THERMOPLASTICS. Evarts G. Loomis. U. S. 2,194,313 March 19. Shaping and surfacing cellulose derivative thermoplastic rods and tubes by means of a die having its inlet orifice in a hot fluid and its body and outlet end in a cold fluid.

POLYMER. H. Berg (to Chemische Forschungsg. m. b. H.). U. S. 2,194,350, March 19. Emulsion polymerization of chloroprene with at least one other polymerizable unsaturated compound in presence of partially hydrolyzed polyvinyl acetate serving as emulsion stabilizer.

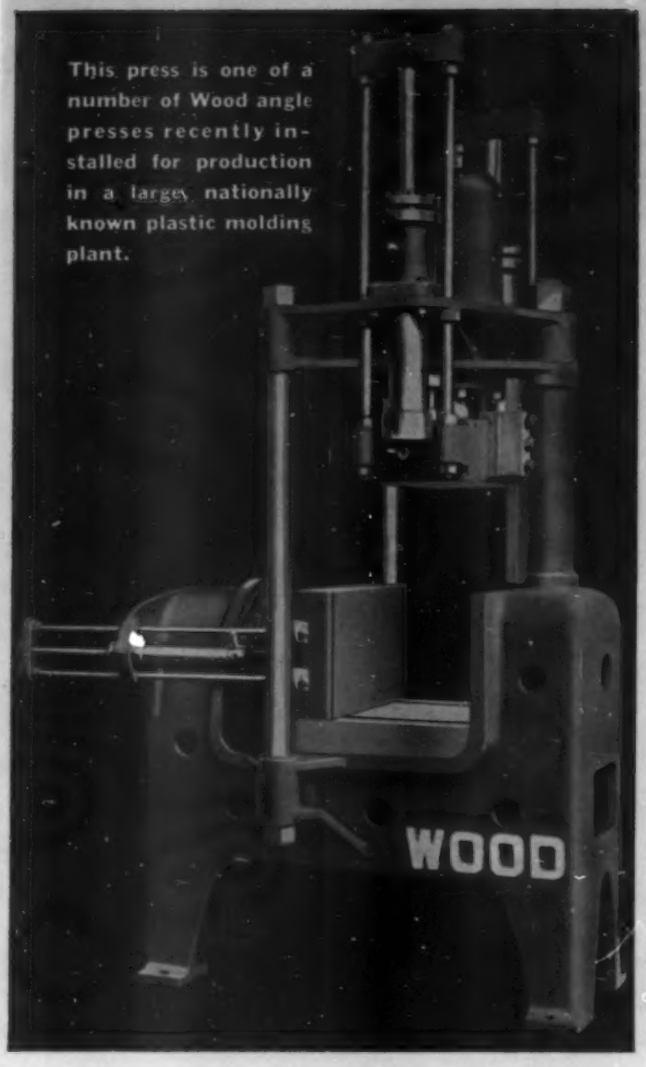
VINYL RESIN. J. W. C. Crawford and J. McGrath (to Imperial Chemical Industries, Ltd.). U. S. 2,194,354, March 19. Preparing a vinyl resin in granular form by emulsion polymerization.

MOLDING PLASTICS. W. H. Wedger (to B. B. Chemical Co.). U. S. 2,194,579, March 26. Milling plasticized chloroprene with a vinyl resin to form a homogeneous blend which is then hot-molded against a matrix.

ACETAL RESINS. G. A. Perkins (to Union Carbide and Carbon Corp.). U. S. 2,194,613, March 26. Making a partial polyvinyl acetal resin by alcoholysis of a polyvinyl ester and partial condensation of the product with an aldehyde.

MODIFIED ALKYD. C. Ellis (to Ellis-Foster Co.). U. S. 2,194,894, March 26. Modifying an alkyd resin with soy bean oil acids.

RESIN STABILIZER. B. W. Nordlander (to General Electric Co.). U. S. 2,195,122, March 26. Stabilizing polyvinyl formal resin with *o*-methylolphenol.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British Plastics Year Book, 1940

Published by Plastics Press Ltd., % Sidney Press, Ltd., Bradford, England.

Price 15/net **464 pages, indexed**

Besides a complete review of "The Role of Plastics in War Time," and an extensive survey of "The Plastics Industry of Great Britain," by V. E. Yarsley and E. G. Cousins, the British Plastics Year Book provides an authoritative guide to the industry and a directory as well. There are nine sections devoted to (1) Editorial; (2) Names and addresses; (3) Proprietary names; (4) Materials; (5) Plant and Equipment; (6) Manufactured products; (7) Associations, etc.; (8) Who's Who in the plastic industry; (9) Data of value to engineers and purchasers. E. F. L.

Sulphated Oils and Allied Products

by Donald Burton and George F. Robertshaw
Chemical Publishing Co., Inc., 148 Lafayette St., New York, 1940

Price $5.00 **168 pages**

The sulphated, or sulphonated as they are usually called, products obtained when fatty acids, fatty oils, and fatty alcohols are treated with sulphuric acid under various conditions, find industrial use especially in the form of detergents, as "cutting" or other machine oils, and in the manufacture of leather. This book briefly surveys the history of the development of these materials and reviews in detail their chemistry and analysis. G. M. K.

Illustration—Its Technique and Application to the Sciences

by Carl D. Clarke, M.A.
Published by John D. Lucas Co., Baltimore, Md., 1940
Price $5.50 **386 pages**

Illustrations for science employ many of the same mediums and methods used in producing any illustration but accuracy of dimensions and clearness of definition are of greater import perhaps than in commercial work. The author, who is Associate Professor of Art as Applied to Medicine, and Director of the Department of Art, School of Medicine, University of Maryland, believes that a good working knowledge of drawing can be acquired by anyone of average intelligence who has a real desire to learn and study basic principles.

The book explains in detail how illustrations are made for scientific textbooks and periodicals, a form of art requiring different and new techniques. It fully discusses the illustration of biological, medical, dental and chemical texts and 272 pictures help visualize each step. E. F. L.

LATEST EDITION OF THE "INDEX TO A. S. T. M. Standards, including Tentative Standards" gives information on all of the 885 standards as of January 1, 1940. The Index is of service to anyone wishing to ascertain whether the Society has issued standard specifications, test methods or definitions covering a particular engineering material or subject and helps to locate the standards in the volumes where they appear. Copies of this 152-page publication are furnished without charge on written request to the American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa.

THREE VALUABLE REFERENCE BOOKS ON TENITE have been issued by Tennessee Eastman Corp., Kingsport, Tenn. Of particular interest to manufacturers and designers, "Tenite," a 28-page book, contains a general description of the properties and uses of the material, and outstanding applications are illustrated by twelve 4-color photos and 86 half-tones.

Prepared for those engaged in molding—a 40-page technical handbook on "Tenite Molding" discusses different types of molds, mold construction, molding temperatures and pressures, and includes diagrams and detailed explanations of 8 typical mold designs. Also, "Tenite Specifications" gives specific data on physical properties for the formulas and flows regularly supplied. This information is presented in tabular and graph form, with supplementary paragraphs of explanation, etc.

All three books have covers laminated with Kodapak, transparent cellulose acetate sheeting. Copies are available without charge from the manufacturer.

WALKER-TURNER CO., INC., PLAINFIELD, N. J., HAS issued a new 52-page illustrated catalog listing its line of light machine tools for metal, wood and plastics. Specifications, prices and features are included for drill presses, saws, grinders, lathes, motors, shapers, surfacers, flexible shafts, etc., and accessories of all types are pictured and described.

NEW TECHNICAL DATA SUMMARIZING THE LATEST information on ethylcellulose and a study of its properties and possible uses are contained in a new 28-page illustrated catalog published by Hercules Powder Co., Wilmington, Del. Extensive tables and diagrams supplement the text.

AN ILLUSTRATED FOLDER GIVING COLOR SUGgestions for bars, soda fountains and other types of counters has recently been issued by the Formica Insulation Co., Cincinnati, Ohio. Color plates illustrating some applications are enclosed.

DOW CHEMICAL CO., MIDLAND, MICH., HAS PREpared a revised 96-page edition of its "Ethocel Handbook," a laboratory manual and reference book for the formulator and user of Dow ethylcellulose. Fundamental information on the properties of the material and an extensive background of information upon its behavior with other components of coating compositions is presented. Specification charts, formulas, tables, diagrams, illustrations of laboratory technique and a complete index add to the value of the handbook. Cover and binding of the catalog are of Ethofoil.

"NEMA LAMINATED PHENOLIC PRODUCTS STANDards" is a reference work of practical information concerning the manufacture, test and performance of laminated phenolic plates, tubing and rod used in the manufacture of electrical apparatus and supplies. Compiled and sold (25¢) by the National Electrical Manufacturers Assn., 155 E. 44 St., New York, the book represents standardized practice in the U. S., suggests production economies, and uniformity and improved quality. The association also issues a bulletin entitled "Recommended Practice for Machining and Punching Laminated Phenolic Plate" which sells for 10 cents.

CARBIDE AND CARBON CHEMICALS CORP., UNIT OF Union Carbide and Carbon Corp., 30 E. 42nd St., New York, has published a 32-page illustrated booklet, entitled, "Solvent Recovery by the 'Columbia' Activated Carbon System," which contains general information about this system of solvent recovery and indicates where it can be profitably employed. The first chapter outlines the development of the use of activated carbon, describes the various grades and types of activated carbon, and mentions numerous low-boiling organic solvents that can be profitably recovered. Advantages of the system are said to include the efficiency and economy with which a moderately priced recovery plant can recover practically all types of vaporized solvents in any concentration—even in the presence of water vapor.

ECLIPSE extends its molding service with *LARGEST* custom *PRESS**

*The largest plastics molding press ever installed in a custom molding plant is now at your service in the Eclipse Company's factory. This giant press, described in the advertisement below, adds almost unlimited size of moldings to the versatility and accuracy that have been characteristic of Eclipse service. Already the largest piece of Lucite ever molded has been pressed on this gigantic machine. Pieces or molds larger than anything ever done before can now be molded—solving plastics problems by adding a new scope to their manufacture. Eclipse service is backed by a thorough knowledge of all plastics and a plant well-equipped for their manufacture.

Largest custom plastics molding press installed in modern Eclipse Company plant

Eclipse Moulded Products Company

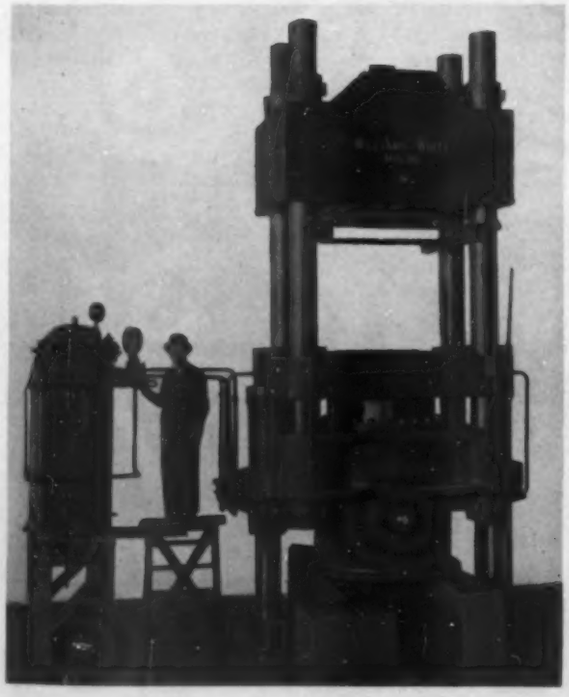
Milwaukee **Wisconsin**

CHICAGO **DETROIT** **ST. LOUIS**

MOULDERS OF

Bakelite, Durez, Resinox Plaskon Tenite, Beetle, and all other Plastics.

FOR **BIG-TIME** MOLDING



THIS *SUPER* PRESS

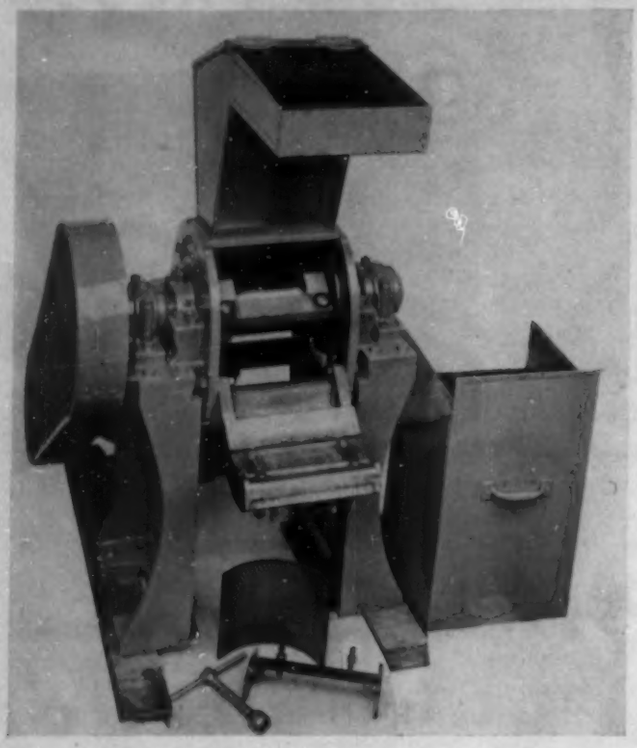
Williams, White & Company has thrown its 86 years of hydraulic press manufacturing experience into the construction of this giant press, one of the largest ever built for a custom molder. This press embodies a wealth of knowledge, derived from a broad background of successful press construction, and insures the Eclipse Moulded Products Company, as well as other users, the economical performance and long life that have become the hallmark of Williams, White hydraulic equipment.

Capacity: 1400 tons. Platen width front to back: 50″
Stroke: 36″. Platen width right to left: 60″.
One main ram and two double-acting kicker rams give rapid closing under no load. Total stripping pressure is 250 tons.

For further information call or write

WILLIAMS, WHITE & COMPANY
MOLINE, ILLINOIS . . . . . U. S. A.
Chicago: 53 W. Jackson Blvd.

Equipment



BALL & JEWELL ANNOUNCES A NEW SMALL ROTARY cutter for grinding cellulose acetate scrap, etc. This new model, called the Ideal (illustrated above) is said to occupy only half the space of a direct-connected motor-driven machine and to have a 25 percent increased screen area. The motor and grinding parts are coincident, connected by a two-belt Texrope drive. There are three revolving and four stationary 10-in. extra-heavy steel knives. A new type hopper is claimed to prevent material from flying out while being ground. The bin is quickly removable for dumping, allowing grinding of different colors in quick succession without danger of mixing. The machine employs a 2 hp. motor, has a capacity of 250 lb. per hr. and can be furnished in stainless steel; comes with or without motor.

A NEW IMPROVED PRECISION TOOL ROOM MILLING machine with preloaded ballbearing spindle construction has been put on the market by Hardinge Brothers, Inc. It incorporates a longer vertical travel to allow the use of the Index head vertically. Spindle noses and collets are interchangeable and there are two high spindle ranges. The machine is offered with or without power feed for longitudinal travel.

CLAIMED TO BE THE FIRST UNBREAKABLE MERcury relay, the new relay made by Durakool, Inc., is of special interest in the fields of thermostatic controls, radios and telephone manufacture. It has an all-metal body, said to be rugged and simple in construction and employs the displacement principle with solenoid actuation.

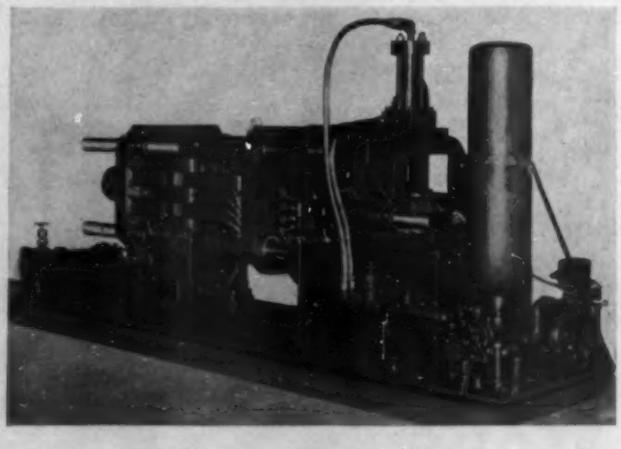
A FLEXIBLE-SHAFT BENCH-TYPE GRINDING MAchine assembly made by R. G. Haskins Co., has a $1/4$ or $1/2$ hp. motor, with an integral control switch, which rides on a ballbearing 360 deg. swivel set on a round base. V-belt and 3-step pulleys connect the motor to the shaft.

CHIKSAN TOOL CO. HAS DESIGNED A NEW HIGH temperature swing joint for operation at working pressures to 500 lbs. at temperatures up to 700 deg. F. According to the company report, care has been taken to provide for unobstructed flow through all bends. Increased diameters are provided at the elbows for maximum flow with minimum pressure drop.

GREATER ACCURACY AND FASTER PRODUCTION IN the duplicating of dies, molds, etc., are said to be among important features of a new low cost duplicating control and drive mechanism announced by Detroit Universal Duplicator Company.

TAYLOR INSTRUMENT COS. HAVE INTRODUCED A completely redesigned line of new Fulscope air-operated recording and indicating controllers for temperature, pressure, rate of flow, and liquid level. In addition to the convenience of combining in one instrument the conventional proportional response and automatic reset forms of control, the new Fulscope introduces a third process-control effect, Pre-Act, a supplementary control feature which makes control-valve corrections according to the rate of control-point deviation. In response to sudden disturbances in the process or variations in the controlling medium, over-peaking or oscillating is greatly reduced by an immediate and relatively larger control-valve action than would occur otherwise, it is claimed. Furthermore, it is said to stabilize operation after a change in set point and when equipment is started up. Other improvements include new, more durable electric chart clock which also is available in explosion-proof housing; spring driven clock is optional; improved rapid chart changing mechanism; Neoprene gaskets throughout.

CENTRIFUGAL MACHINES FOR SEPARATION, EXtraction, dehydration, coating, filtration, thickening, impregnation and sedimentation and varied chemical process jobs, are supplied in a wide variety of models by American Tool & Machine Co. Growing out of the three basic types of centrifugals (link suspended, suspended and base bearing) these machines are made in special sizes when required and can be adapted for specific jobs, the company reports. Some of these adaptations are 2-motor free-wheeling drives, fume-proof hoods, explosion proof motors, special baskets for more drainage, and link-type separators to handle three separate processes within one frame.



THE G. & M. MFG. CO. ANNOUNCE TWO NEW HIGHpressure hydraulic die-casting machines designed to accommodate larger dies, to increase production and reduce waste, to give a tighter seal on dies and largely eliminate flash. We picture one of these machines (above) to show its rugged construction because we understand the G. & M. Co. is planning to apply these same engineering principles of maximum efficiency and minimum maintenance to an injection press for high-speed plastic molding to be available late this year.

AN ASH TRAY OR A WHISTLING KETTLE

Whether it's a decorative knob as used on Revere Copper & Brass Co.'s *whistling kettle*, a lustrous rim for the unique "Pick-Me-Up" ash tray by the same company . . . or a precise electrical or mechanical part with unusually close tolerances—it's worth your while to take advantage of Auburn's trained personnel and 64 years of built up experience.

A standard of workmanship that is "tops" in plastics, plus a long series of rigid inspections, insures quality that means satisfaction for you and a better sales chance for your product . . . often at lower costs. Let an Auburn engineer work with you on your next molded plastic job. Write.

Established 1876

MOLDED PLASTICS DIVISION OF

AUBURN BUTTON WORKS, Inc.

AUBURN, N. Y.—New York, Chicago, Detroit, Cleveland, Syracuse, Boston

3 NEW COMPOSITIONS

developed exclusively for

BUFFING PLASTICS

•

LEAROK No. 436
for cutting down

LEAROK No. 746
for cutting and coloring

LEAROK No. 766
for color buffing

These three different grades of Learok are along lines entirely new to the art of polishing and buffing, yet logical for the plastic industry.

Lea Technicians, who have been and continue to be so helpful to the metal-working industry, are now spending much of their time on plastic polishing and buffing problems. In placing trial orders, please give details as to the kind of plastic being finished and the operations now being carried out.

THE LEA MFG. CO.

WATERBURY, CONN.

Specialists in the Production of Clean-Working Buffing and Polishing Compounds

They Say

CONTRACTS FOR THE DESIGN AND CONSTRUCTION of an integrated modern plant for the Hydraulic Press Mfg. Co. have been awarded to the Austin Co., engineers and builders. The development will represent an investment of approximately $500,000 for building and equipment and will occupy a new 60-acre site recently acquired at Mount Gilead, Ohio.

Howard F. MacMillin, president of the company, stated that this new plant will be devoted exclusively to the manufacture of its line of H.P.M. *Fastraverse* hydraulic presses, high-speed, self-contained machines of modern patented design. They are employed in pressing parts of metal, plastics and materials for automobiles, aircraft, domestic appliances and other products.

FORMICA INSULATION CO., CINCINNATI, OHIO, HAS succeeded in laminating thin sheets of stainless steel on canvas or linoleum base so it can be cemented to walls or other surfaces with an ordinary adhesive. Being thin and flexible, the laminate will bend to any reasonable radii. The steel and linoleum are laminated with a newly developed resin adhesive which insures a permanent bond.

J. D. SHERMAN, VICE PRESIDENT AND GENERAL manager of Reynolds Spring Co., reports that John G. Rossiter, formerly sales manager of the company's plastics division, is no longer connected with the organization. Robert R. Wilson, formerly in charge of the Cleveland office, has been appointed to fill the position.

CELLULOID CORP. REPORTS THE REMOVAL OF ITS New York headquarters to 180 Madison Ave. Besides the sales and credit offices, there is a show room for the display of a variety of plastics products and of raw materials made by the company.

A NEW AREA SALES OFFICE OF THE GENERAL ELECtric Co.'s plastic department was established in Rochester, N. Y., recently under the direction of A. G. Davidson, Jr., sales representative. This is the ninth sales office to be established by the department, and the second during this year, according to G. H. Shill, manager of the plastics department. For the past three years Mr. Davidson has been located in the department's Meriden, Conn., office. The G-E plastics molding plants are in Pittsfield, Mass., and in Meriden, and the laminating plant in Lynn, Mass. Other sales offices are now located in Fort Wayne, Ind., Chicago, New York, Philadelphia, Meriden, Detroit, Cleveland and Lynn, under the direction of W. H. Milton, Jr., sales manager.

BRIDGEPORT MOLDED PRODUCTS, INC., BRIDGEport, Conn., report that Harry Broumel (formerly connected with American Insulator Corp.) is now in charge of its New York sales office at 220 E. 42nd St.; telephone, MUrray Hill 2-0654.

LAMINOID, INC., FORMERLY A DIVISION OF SHOUPOwens, Inc., manufacturer of paper boxes, reports it is undertaking additional financing in order to increase its capacity and move to a separate plant. Up to the present, the company has specialized in laminating rolls of cellulose acetate, or acetate film to printed matter, paper, paper board for packages, display cards, book covers, phonograph records, etc. In the contemplated new quarters, it plans to extend its research efforts while enlarging its activity, especially in the lamination of textiles.

RAYMOND LABORATORIES, INC., ST. PAUL, MINN., have completed a substantial plant expansion program, including the installation of a sizable plastic molding and plastic die-making department, Raymond E. Lee, president of the company, informs us. They are equipped for custom compression molding.

PLASTIGLAS PRINTING, INC., A NEWLY FORMED corporation specializing in printing on plastics and glass, acquired on March 21 the machinery and equipment of Color-Kraft, Inc., according to Scott Stewart, president of the new company. It has taken over the personnel and will carry on business of the previous organization at 626 W. 44th St., New York. Arthur M. Stewart and Arthur W. Paegelow have been elected vice president and secretary-treasurer, respectively.

HERESITE & CHEMICAL CO., MANITOWOC, WIS., according to an announcement by C. H. Hempel, president, has appointed Edwin C. Schreihart, works chemist for the past five years, plant manager and Henry Wernecke, sales manager. The company is represented in the east by Rice & Malone who have headquarters at 75 West St., New York, and in the Commercial Trust Building, Philadelphia.

CHARLES L. KELLER HAS SUCCEEDED J. M. RICHARDson as president of the Richardson Co., Lockland, Ohio. Mr. Richardson is now chairman of the board of directors. The company maintains a molding and laminating plant at Melrose Park, Chicago, besides its paper box manufacturing plant.

LAWRENCE H. WILSON, PRODUCT DESIGNER, REports the opening of new offices at 913 Stephenson Building, Detroit. Mr. Wilson states that he has had wide experience in this field, having served for several years as stylist to Norge and Detroit Vapor Stove, divisions of Borg Warner Corporation.

DESIGNED FOR USE AS A DISTINCTIVE TYING MAterial, a new decorative cord coated with a plastic material has been introduced by Freydberg Bros., Inc., Stamford, Conn. The cord is claimed to be completely flexible, pleasant to the touch, easy to knot and tie and the plastic surface will not chip or peel off. It is produced under micrometer-exactness, it is reported, and its diameter is unvarying throughout its length. It is packed in a special self-dispenser spool (pictured above) which is provided with its own cutting device. Sample cards showing full range of colors are available from the manufacturer.

THE FRANKLIN INSTITUTE, PHILADELPHIA, PA., announces that the Franklin Medal will this year go to Dr. Arthur H. Compton, University of Chicago and Nobel Prize Winner for Physics (1927), and Dr. Leo Hendrik Baekeland, chemist, founder and former president of Bakelite Corp. The medal to Dr. Baekeland is given "in recognition of his inventions and his contributions to the improvement of the industrial arts, and, in particular, of his invention and manufacture of the synthetic product—*Bakelite*." The award to Dr. Compton is made "in recognition of his brilliant experiments on various properties of x-rays, some of which involved new methods of attack, and, in particular, for his discovery and theoretical treatment of the Compton Effect." (*Please turn to next page*)

THE LIST OF USERS OF THE CARVER LABORATORY PRESS

is a "who's who" of American Plastics

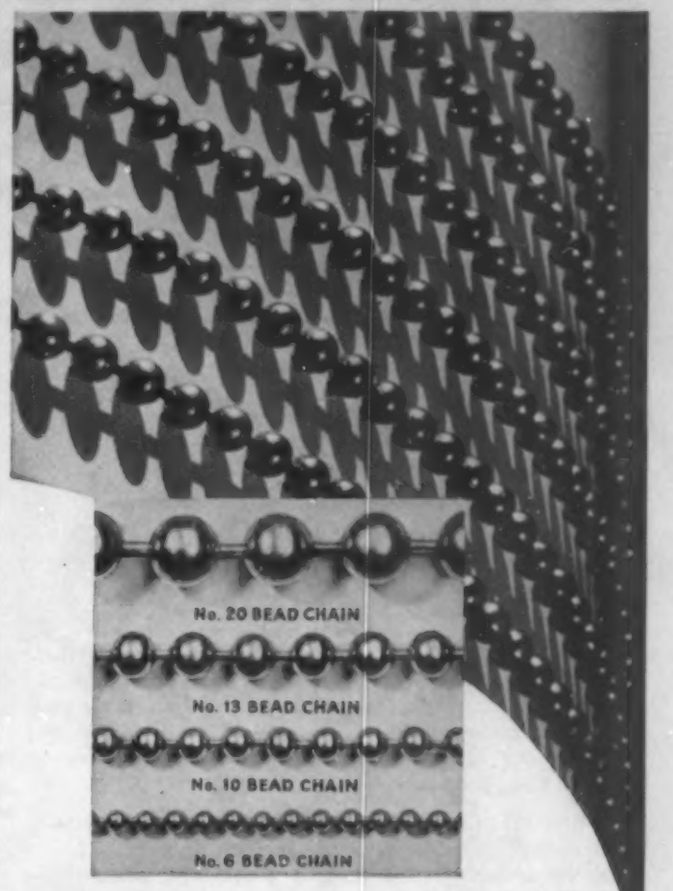
The Carver Laboratory Press has become the standard press for plastics research in thousands of firms and hundreds of university and government laboratories —all over the world! The reasons are simple: it is designed for research. It is lightweight: 125 lbs. Yet it gives pressure up to 10 tons—and repeatedly, without faltering. It has been in actual use for upwards of 12 years without mechanical failure—and still going strong!

Both electric and steam hot plates are available for molding thermoplastics and thermosetting plastics. Platens are 6" X 6". Height, 36", depth 15½". Hand operated—and can be carried easily by one man.

Also comes equipped for general research, with interchangeable accessories for more than 60 general applications, subdivided into hundreds of specific uses. Just plug into a light socket and go to work!

THE CARVER LABORATORY PRESS
FRED S. CARVER
HYDRAULIC EQUIPMENT
343 HUDSON ST., NEW YORK
***In London* BAKER PERKINS Ltd.**

INGENUITY



BEAD CHAIN*

The swiveled construction of BEAD CHAIN* permits its use in many ingenious ways. It is made in sizes and with couplings to fit the need, and the smooth metal beads have a decorative value that is frequently most desirable. When color is required, BEAD CHAIN* may be had in durable lacquered finishes.

For 25 years we have cooperated with manufacturers in many fields to develop effective assemblies of BEAD CHAIN* for their products. Can we help you?

BEAD CHAIN
ESTABLISHED 1914
Trade Mark Reg. U.S. Pat. Off.

THE BEAD CHAIN MANUFACTURING CO.
*** Reg. U.S. Pat. Off. 60 MT. GROVE ST., BRIDGEPORT, CONN.**

ROBERT S. PEARE, PRESIDENT AND GENERAL MANager of the Maqua Co., a printing and engraving concern affiliated with General Electric in Schenectady, has been named manager of the publicity department of General Electric Co., it was announced today by President Chas. E. Wilson. He will assume his new duties at once, succeeding Chester H. Lang, who becomes manager of apparatus sales for the company.

METHODS OF PRODUCING ACRYLIC ESTER RESINS from lactic acid obtained from whey have been reported by the U. S. Bureau of Dairy Industry. Research is being concentrated on acrylic copolymers with other polymerizable compounds, rather than on the simple polymers. The study of the proteins of alfalfa as a raw material for plastics manufacture has been undertaken at the Michigan State College. The preparation of plastics from saw-dust by hydrolysis with aniline and plasticizing with furfural was reported by the Forest Products Laboratory. (National Farm Chemurgic Council Bulletin.)

THE APPOINTMENT OF GEORGE C. MILLER AS sales manager of the Plastics Division of Carbide and Carbon Chemicals Corp. is announced by H. S. Bunn, manager of the Plastics Division.

FORMATION OF BONWIT-INTERNATIONAL CO., A company recently organized to act as distributors for manufacturers of plastic products, is announced by S. Robert Bonwit, president. Headquarters are 32 Broadway, New York.

MICHIGAN MOLDED PLASTICS, INC., DEXTER, MICH., reports that John G. Rossiter is now connected with the company as general manager. L. N. Seybold, for 20 years chemical engineer at Reynolds Spring Co. is associated with Mr. Rossiter. The company fabricates plastics by the extrusion, injection and compression methods.

EXTRUDED PLASTIC TUBING, DEVELOPED FOR ELECtrical insulation, or for fields where flexible tubing is used in wire insulation against heat, moisture, oils, etc., is being manufactured by Irvington Varnish & Insulator Co., 24 Argyle Terrace, Irvington, N. J. This material, extruded in continuous lengths is produced in five standard colors from size No. 20 to $^{3}/_{8}$ in. and can be specified in different sizes and wall thicknesses. It is said to have good mechanical strength, tear and abrasion resistance, improved chemical and electrical characteristics, flexibility, inside and outside smoothness, and is claimed to withstand soldering temperatures and other heat without flow.

IT HAS BEEN POINTED OUT TO US THAT ITEM 19, Plastics in Review, April issue, was credited to the wrong manufacturer. The miniature facsimiles of automobile license numbers attached to key chains which we pictured were made by Le Roco, Inc., 266 W. 55th St., New York, using a Lumarith transparent shield to protect the insert. Of course, we are sorry, but the error was not entirely without benefit. It gave us an opportunity to meet Mr. J. J. Ross, head of Le Roco, personally. It gave him an opportunity to picture here, above, a more recent addition to his line of miniatures. And now, we have a brand new key chain with our own license number for our personal use.

Transparent gloves made from polyvinyl alcohol resin, a new du Pont product

A NEW GROUP OF WATER-SOLUBLE, WATER-DISPERsible vinyl resins which can be molded, extruded or formed into sheets is announced by E. I. du Pont de Nemours & Co. The resins are described as polyvinyl alcohols and have been designated as PVA. Properties suggest an extraordinarily wide range of industrial possibilities. A hard tough plastic may be obtained by heating in a mold under pressure. If plasticized before molding, rubber-like products of extreme elasticity and flexibility are said to result. Various plasticizers and grades of the resins will produce any desired degree of softness.

The resins display characteristic resistance to the action of oils, fats and most organic solvents including chlorohydrocarbons, aromatic hydrocarbons, carbon disulfide, alcohols, esters, ethers or ketones. They are resistant to the action of oxygen, ozone and to deterioration caused by vibration and flexing. PVA is free from sulfur and its films possess a high degree of impermeability to gases such as hydrogen, hydrogen sulfide, etc., it is said.

Polyvinyl alcohol sheeting, or glass coated with it, provides windows which are not only rendered safer against shattering but which will not fog under conditions of high humidity inside a room and low temperature outside. Such a composition can be used on automobile windshields and on windows for gas masks. In some cases, depending on the nature and composition of the article to be molded, the ordinary flash type of mold as used in the rubber industry can be employed. In other cases, positive pressure types are recommended. Molds often can be packed with the plasticized PVA powder while in other cases it is better to use a preformed sheet made either by pressing the powder in a mold or by milling the plasticized powder. Various fillers can be added to the molding composition during milling if desired.

Plasticized PVA compositions are extruded in the form of tubes, rods, sheets and threads. Tubing and hose are now commercially available. Tubing is extruded by methods similar to those used in making rubber tubing.

The plain, unpigmented tubing is transparent and almost colorless. It has low specific gravity, high tensile strength and high abrasion resistance at low temperatures. The tubing also is claimed to have remarkable ability to transmit speech and other sound, with minimum distortion and little absorption by the tube wall. Application in dictating machines and sound equipment is expected.

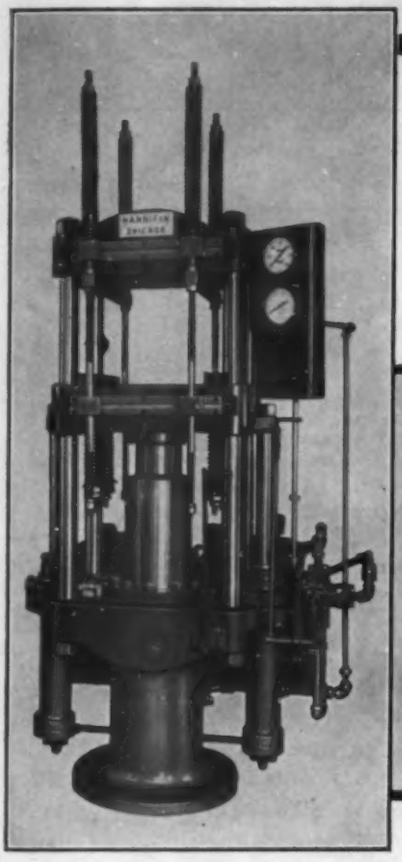
The resins are manufactured in a number of grades, since proper selection is necessary to meet individual requirements. In general, polyvinyl alcohols are white to creamy white powders, odorless and tasteless. No toxic or inflammable solvents need be employed, and, if desirable, the film can be made waterproof.

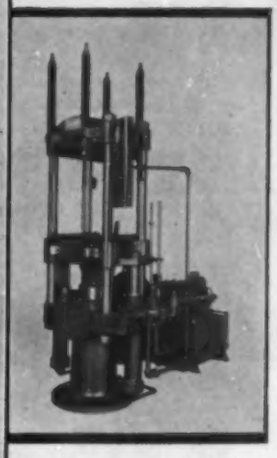
DUREZ PLASTICS & CHEMICALS, INC., NORTH TONAwanda, N. Y., announces an addition to its new 1900 Black series of phenolic molding compounds, to be known as Durez 1905 Black. This material is said to have an impact strength of 0.6 (A.S.T.M.) and heat resistance of 418 deg. F. Unusually good gloss for high-impact compounds is reported with this material. It is available only in the new particle size which is especially designed for free flowing through feeders and hoppers to simplify the production of preforms. Due to the high bulk factor of this series, deeper preform cavities are required. Otherwise, thin preforms will result.

A New

HANNIFIN HYDRAULIC PRESS

designed especially for molding





Capacity 125 tons. Between columns 24 in. Daylight, platen down, 32 in.; platen up, 14 in. Stroke 18 in.

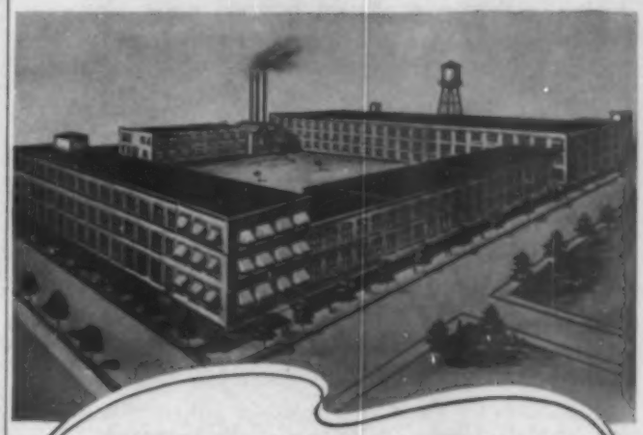
● This Hannifin 125-ton hydraulic press for molding operations, built like a modern machine tool, provides rapid operation, with simple control, in a compact self-contained installation. Hannifin hydraulic press design, backed by over 30 years of specialized experience, and Hannifin precision construction are proving their value in many of the leading manufacturing plants. Standard design hydraulic presses of this type are available in capacities of 125-200-300 tons, with or without motor-driven hydraulic power units. Hannifin engineers will gladly submit specific recommendations.

HANNIFIN MANUFACTURING COMPANY
621-631 South Kolmar Avenue • Chicago, Illinois

ENGINEERS • DESIGNERS • MANUFACTURERS
Pneumatic and Hydraulic Production Tool Equipment

GENERAL
FRED'K. WM. VON STEUBEN
. . . He Was Efficient

Trained in the military tradition of Frederick the Great, General von Steuben contributed immeasurably to increase the efficiency of the American forces. He has very properly been called "The Drillmaster of the Revolution," for he took a throng of raw colonials and whipped them into a disciplined effective force.



GENERAL INDUSTRIES

molds plastics efficiently for you

You profit in many ways when you make General Industries your source of supply for molded plastics. General Industries' efficiency works for you in

★ Making plastic parts accurate in dimension and true to conformation. "They fit."

★ Taking over entire responsibility. We make our own molds and can make any or all metal inserts in our machine department.

★ Saving money with our rock bottom prices. Nowhere else will you find price and quality more consistent or favorable.

★ Delivering on time. You can depend on getting what you want when you want it.

Submit plans of your next job to us

THE GENERAL INDUSTRIES CO.
Molded Plastics Division
OLIVE AND TAYLOR STREETS • ELYRIA, OHIO

Plastic bearing materials

(*Continued from page 57*) by steps to full speed. If the load be applied too quickly the excessive heat generated on the sliding surfaces might cause seizure. By frequent loading and unloading at various speeds the plastic bearings finally become insensitive to pressure increase as they become better fitted to the journal. The bearing can be considered well run in when the originally light-colored and finished areas disappear and form a light-colored, mirror-like, uniform surface. The bearing friction and temperature, which at the beginning were high, decrease considerably at the end of the running-in period. This period usually requires several days and can be substantially reduced by good machining of the sliding surfaces. Such running-in performance is very well represented graphically in Fig. 5. A bearing with textile laminae perpendicular to the axis, impregnated with cresol, was run in on a testing machine with forced-feed oil lubrication during 110 hrs. The bearing pressure was increased in steps of 75 psi after steady-state conditions were reached. The friction torque and temperature increased gradually with the loading until at a pressure of 370 psi they rose suddenly and the journal speed dropped rapidly. After a few minutes, however, the torque and temperature readings decreased and their values slowly reached lower readings than previously recorded. By a further similar loading procedure the torque and temperature rose again as may be noticed in Fig. 5. At a pressure

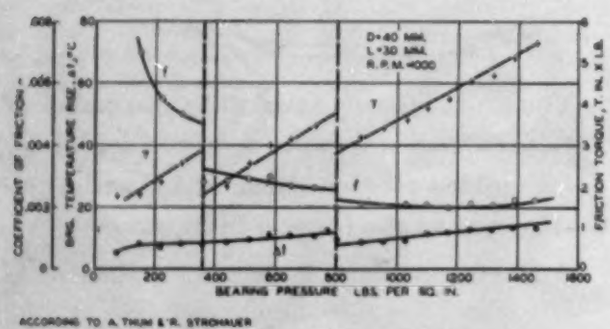
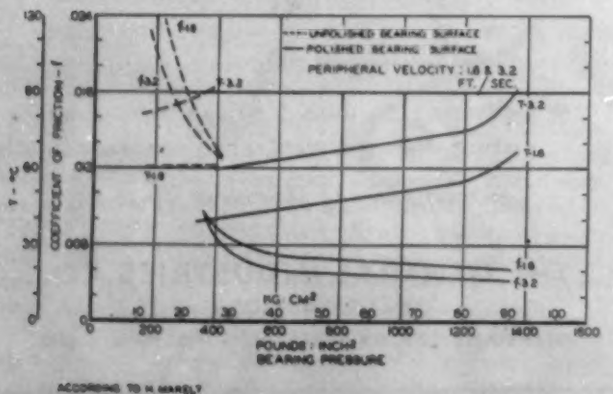

D=40 MM.
L=30 MM.
R.P.M.=1000
COEFFICIENT OF FRICTION - f
BRG. TEMPERATURE RISE - Δt °C
FRICTION TORQUE, T IN. X LB.
BEARING PRESSURE - LBS. PER SQ. IN.
ACCORDING TO A. THUM & R. STROHAUER

Fig. 5 (above)—Running-in performance of a laminated bearing. Fig. 6 (below)—Bearing performance of railway bearing

(*Material: Laminated textile sheets impregnated with cresol 65 percent resin*)



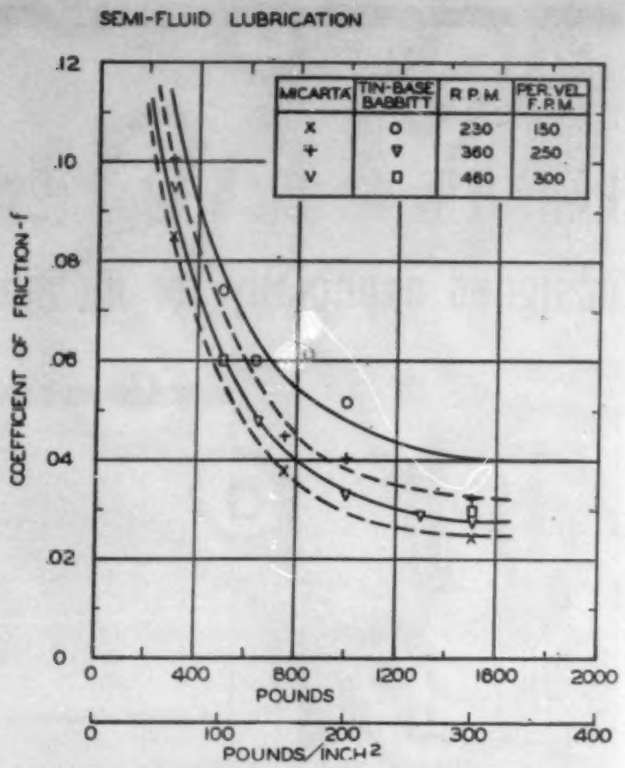


Fig. 7—Comparison of friction of grease-lubricated phenolic laminated and oil-lubricated tin-base babbit bearings

of 800 psi the torque and temperature reading went again off scale and the journal slowed down. After a few minutes the torque and temperature decreased again and rose slowly with increased load. The variation of the coefficient of friction may be seen also on the curve in Fig. 5.

An article published recently on the performance of railway bearings[12] also points to the importance of running-in performance. This is done in connection with laminated textile material impregnated with cresol resin (65 percent resin content). This running-in period is artificially accelerated by removing the upper layer of the bearing surface and polishing it by means of a special bushing having the same diameter as the bearing journal. As shown in Fig. 6, such bearing before the surface layer is removed performs with a value of the coefficient of friction which is in the boundary region. At a pressure of slightly over 400 psi the bearing seized. However, the same bearing after the upper bearing surface was removed and polished performed satisfactorily at much higher loads in the region of fluid film lubrication. These tests were carried on several bearings at peripheral velocities of 1.6 and 3.2 fps. Bearing temperatures are also plotted in Fig. 6. Optical measurements of bearing surface finish were made[13] on new and worn bearings; this, it is hoped, will help in further study and improvement of the performance of synthetic resin-bonded materials made for bearings. This is especially so since

12. Kunstharzlager für Schienenfahrzeuge, by H. Mäkelt, Kunststoffe, 29, 143 (May 1939).

13. Optische Oberflächenprüfung von Kunststoffen, by H. Klingelhöffer and H. Müller, Kunststoffe, 29, 14 (Jan. 1939).

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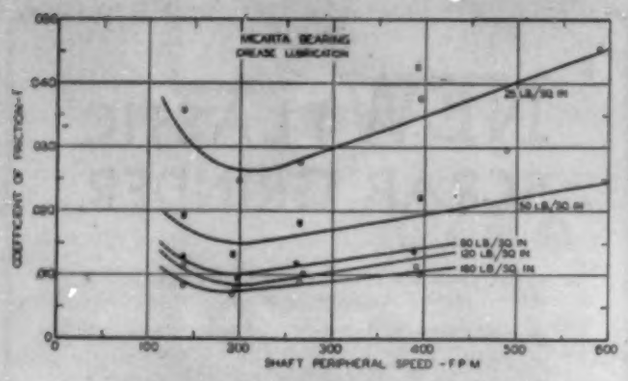

Fig. 8—Variation of the coefficient of friction with peripheral velocity and pressure

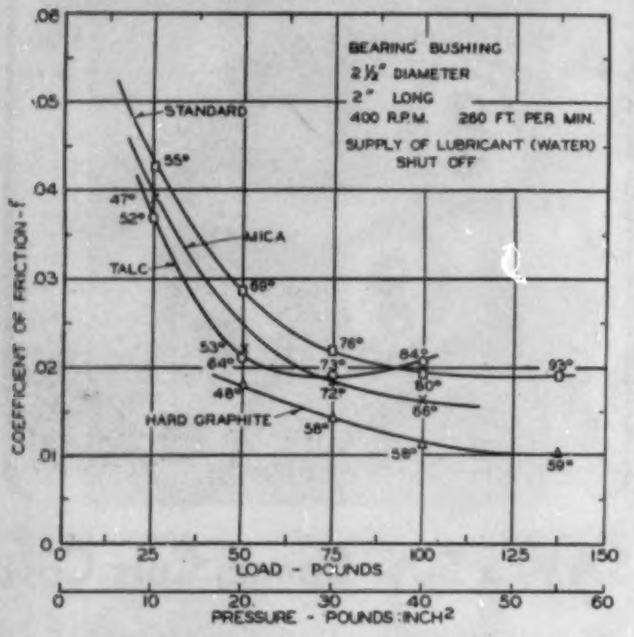

Fig. 9—Influence of additions to synthetic-resin bearing materials upon the value of the coefficient of friction

finish measurements of journal surfaces are now made[14,15] and the performance of bearings can be elucidated also from this important point of view.

Fig. 7 indicates that the performance of a grease-lubricated phenolic laminated bearing is approximately identical with that of an oil-lubricated babbitt bearing, both in the boundary region. These tests were made at various pressures and peripheral speeds while using a $2^1/_2$-in. diameter bearing bushing 2 in. long. Fig. 8 shows the results when another type of phenolic laminated bearing material lubricated with grease was tested at various loads and speeds. The friction properties of synthetic resin-bonded materials can be improved by various additions. The variation of the coefficient of friction depending upon such additions is shown in Fig. 9. These experiments were made on

14. Boundary Friction in Bearings at Low Loads, by L. M. Tichvinsky and E. G. Fischer, Journal of Applied Mechanics, Trans. A.S.M.E., *61*, A-109 (1939).

15. L'état de Surface des pieces Mécaniques, by P. Nicolau, Université de Lille, 1939, Reprint from Genie Civil, February 18-25, 1939.

16. Wear in Lubrication Problems, by L. M. Tichvinsky, Trans. A.S.M.E., *61*, no. 4, 335 (May 1939).

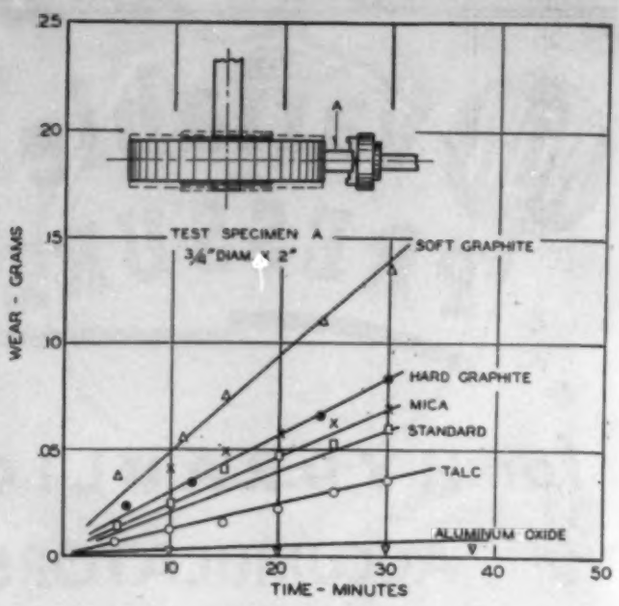

Fig. 10—Influence of additions to phenol laminate upon the wear

the machine previously described by the author.[14] All bearings tested were run in for a few hours with a small amount of lubricant. Its supply was then shut off and the values of the coefficient of friction and of the temperature were recorded for different pressures. The standard phenolic laminated, as can be seen, performs with a higher friction and temperature. Additions of mica and talc decrease both the friction and the temperature. A marked improvement is obtained when hard graphite is added to phenolic laminated; the values of the coefficient of friction are low and so is the temperature, due to the improved heat conductivity as mentioned previously.

The wear properties of the same materials were also investigated on the wear-testing machine previously described by the author.[16] The principle of the machine is sketched in Fig. 10. The rotating test specimen *A* is pressed on the rotating and oscillating outside surface of a hard disk. A small jet of water is played upon the disk for removing the heat. The loss in weight of the specimen gives a comparative measure of wear. The addition of aluminum oxide greatly improves the wear qualities of phenolic laminate. The rate of wear of the standard *Micarta* is approximately the same when hard graphite and mica are added to it.

The foregoing data and several performance examples, it is hoped, will assist a designer in his work when selecting and specifying synthetic resin-bonded bearings. Being made of a comparatively new material, the plastic bearings now find wider application, and are being improved by constant development and study.

Acknowledgments

The writer thanks the Westinghouse Electric and Manufacturing Co. for permission to publish this paper. All the data of experiments performed by the author were made with the assistance of E. G. Fischer, of the Westinghouse Research Laboratories, and C. Jahing, graduate student.

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10

Varnished mast hoops of standard rivet oak (left) and phenolic-bonded plywood (right) after being subject to hot water, steam, cooling, sun and salt water tests. The results are apparent from the illustration

Plywood joins the marines

(*Continued from page 29*) the pram was held to 68 pounds. It proved so popular and was so comparatively inexpensive to build that the company developed a 15-ft. Featherweight centerboard sloop utilizing the same type of construction and planked and decked with plywood. This boat weighed from approximately 150 to 200 pounds less than one built in the conventional manner.

In addition to meeting the rigid tests of boat builders, the new phenolic bonded plywood brings many advantages. It is not lower in actual cost than plain lumber in the same woods but there's a complementary saving in labor costs. Further, there's practically no waste from inferior stock. There's a huge saving in weight, as has been pointed out in the two specific cases mentioned. Yet there is no sacrifice in strength. In fact, for the same weight there's greater strength. Due to the construction of plywood it will not split easily—the cross-graining giving it great resistance—a characteristic which must be achieved with double planking when ordinary lumber is used. The bond between the plies is so strong that an attempt to split the plywood at the glue line is no more successful than at any other point. Contraction and expansion of this plywood is almost negligible. Consequently, in many cases caulking is unnecessary. The phenolic resin bond has been proved definitely to retard and almost completely stop termite and fungus growth. It inhibits dry rot. Even the rats seem to stop at the glue line.

Leading designers in the east and west are today designing boats to take advantage of the properties of phenolic bonded plywood. Look at the sloop designed by Henry M. Devereux (Fig. 1, page 27). She's a beauty, trim and neat, yet ruggedly constructed. Illustrations (Figs. 4–9, page 29) of this boat under construction reveal the simplicity of using these new plywoods. One view (Fig. 8) in particular is worthy of special note. It shows the hull complete after being sanded and having a prime coat applied. From a few feet away you can't see a seam or a joint. Try it with the planked hulls and from the same distance every seam and joint are visible.

C. R. Dillabaugh Co. of Portland recommended a resin-bonded plywood for many of their designs—for their small *Dildinghy*, for a 12-ft. rowboat, for duckboats, runabouts (Fig. 3), racing runabouts and trailer class sailboats. Typical of their comments on their various designs is this: "As this boat was designed especially for plywood construction, it should not be planked with ordinary lumber. The core of plywood substitutes for many of the frames in a boat that is planked with sawed lumber. For that reason there are not nearly as many frames or ribs as would be required if it were not planked with plywood. This makes a lighter boat, and at the same time a stronger boat. But when building this boat of plywood, great care must be taken that the proper kind of plywood is selected. The layers of an unsuitable plywood (not bonded with phenolic resin) soon soak loose when immersed in water and cause no end of trouble."

Still another use of phenolic bonded plywood is for superstructures of tugboats, barges, and the like. The story revealed by the owners of the tugboat *Invader* (Fig. 2) is one that may be well taken by other such owners or builders. The *Invader*, newest addition to the tugboat fleet of the Tidewater Transportation Co. of Spokane, has penetrated farther up the high reaches of the Columbia River than any of her sister ships because her superstructure was built of resin-bonded plywood instead of metal. The saving in weight made considerable difference in the draft of the boat. The *Invader* is 90 ft. overall with a 24-ft. beam and has only a 4-ft. draft. With a conventional tunnel stern used in shallow water and powered by two twin screw Diesels of 600 horsepower, it will handle a 200,000 gallon barge with comparative ease up the swift waters of the upper Columbia. The architect of the *Invader* is Phil Mitchell.

Practically all of the plywood that is finding its way, now well paved, into boat construction is of the phenolic resin-bonded type. It is manufactured under one of two processes covered by basic U. S. patents No. 1,299,747 of J. R. McLain of Westinghouse Electric Mfg. Co. and No. 1,917,020 of Harry M. Dent of Durez Plastics & Chemicals, Inc. The former involves thorough impregnation of a thin cellulose material, such as paper or cloth, with a phenol-aldehyde resinous product. The sheet is dried and further polymerized by passing through a hot oven. It is then cut to the desired size, placed between two veneers and pressed in a hot hydraulic press. The hot-pressing operation softens the resin film sufficiently to bond to the wood fibers and then sets up or cures to an infusible, insoluble bond. This method of producing plywood places the resin exactly where it is wanted, at the junction between the veneers. This is a distinct advantage over the use of, for example, liquid resins which soak deeply into the veneer and which, consequently,

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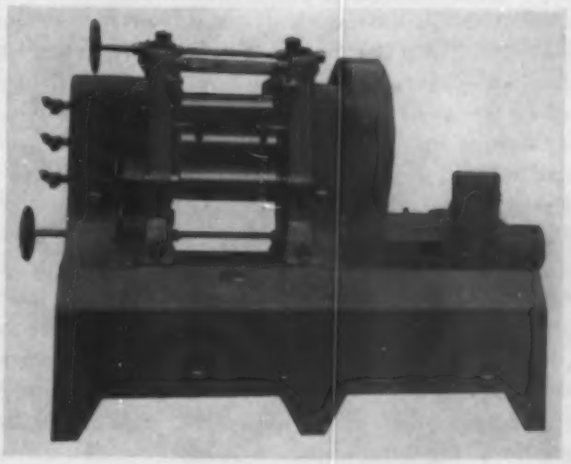

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must be used in large amounts to obtain a satisfactory bond. Because the resin does not soak in, thin surface veneers are not discolored by bleeding of the resin from the film glue.

Another eminently practical method of accomplishing the same result is to use as a glue in hot-press operation a colloidal dispersion of a heat-setting resin in a liquid which does not dissolve the resin. This device permits the application of the suspension to the veneer surface, following which the suspending liquid either soaks into the veneer or evaporates, leaving the bonding resin on the surface of the veneer—exactly where it is wanted. This method of bonding plywood is covered by U. S. Patent No. 1,917,020 of H. M. Dent. Various types of resins may be used as bonding agents in this process—for example, urea-formaldehyde, glycerol-phthalic anhydride, ketone resins. However, the process has been used mainly with thermosetting phenolic resins, chiefly because of the low cost and absolute waterproofness of these resins.

It seems that no matter where you turn today you'll find the new water-, weather-, fungi-, termite-proof plywood being adopted by the boat-building industry. Combine this new structural material with coatings of phenolic resin base varnishes and paints and you have almost achieved the impossible in boat construction—a boat that slides through the water as though on wings, that has the staying qualities of time, the beauty of a Godiva, and the upkeep of a new baby.

Traditional transition

(*Continued from page 33*) were cementing difficulties, too, and joining techniques had to be perfected.

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While this is the first extensive use Grosfeld House has made of plastics, it isn't the first time that these materials have appeared in its exhibition rooms. Back in 1935, cast resins were used in light niches and for drawer pulls. A huge, ornamental cast resin screen, experimentally designed about that time, still stands in the reception hall of the building, and in one of the rooms is a breakfront with a "Chicken-wire" screen across the front made of cast resin tubing, cut into pieces and cleverly spliced together (Fig. 12). Laminated material, too, has been used from time to time for table tops.

With this use of the clear methyl methacrylate resins for general production, the successful invasion of plastics into the furniture field should point the way to a permanent, growing occupation.

12

13

The "mesh" front of this breakfront* 12 *is made of Catalin tubing, cut into pieces and spliced together. Another view of the Grosfeld House Glassic living room* 13, *shows delicate, graceful transparent tables, novel table lamps and fireplace decorations made of Plexiglas

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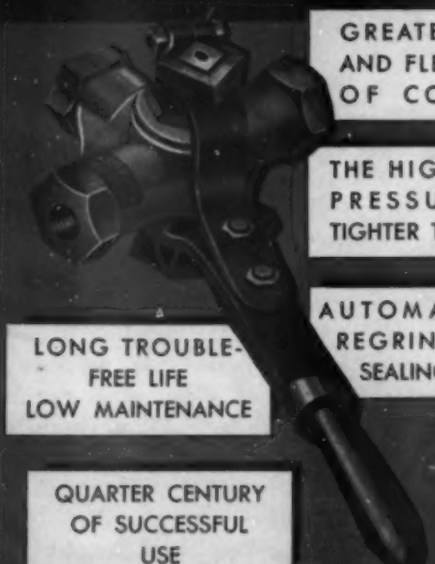

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Student design

(*Continued from page 37*)

The contest, which was limited to students in the Department of Painting and Design, carried a total of $250.00 in cash awards. Thirty students competed.

There were three main classifications—apparatus, household items and style items. Eight designs were submitted in the first classification which had an adding machine, a radio cabinet and kitchen scale as subjects. Twenty designs were entered in the household division, which included cannisters, thermometers, a domestic lighting fixture, and stove hardware and accessories. Style designs numbered twenty-two, with the students having a choice of shoe trees, electric clocks, cosmetic packages, airline dining tray and packages for a wrist watch. Total number of entries was fifty.

First awards of $50.00 each went to Frank Zavada, an evening school student, for stove hardware; Gilbert McMurtrie for an airplane dining tray; and to William Winterbottom for a kitchen scale. Second awards of $25.00 went to James J. Winkworth for stove hardware; Raymond Cyphers for a watch package; and to Dolores Niehoff for a radio cabinet. Louise Cruthers won a third prize of $15.00 for a cosmetic package container, and honorable mention and $10.00 was awarded Marjorie King of Pittsburgh.

Judges of the competition were Dr. M. H. Bigelow and Whiting N. Shepard of the Plaskon Co.; Dr. R. L. Wakeman, specialist in plastics on the research staff of the Mellon Institute, Pittsburgh, and Peter Müller-Munk and Robert L. Lepper of the faculty of the Carnegie Institute of Technology.

S. P. I. at Hot Springs

(*Continued from page 39*) Elmer E. Mills; Modern Plastics: Charles A. Breskin, Dr. G. M. Kline, E. F. Lougee; Monsanto Chemical Co.: George C. Gress, Charles Lichtenberg; Niagara Insul-Bake Specialty Co., Inc.: A. R. Van Horne; Norton Laboratories, Inc.: J. R. Neal, H. G. Valentine; L. M. Payne Co., Inc.: C. H. Allin; Plaskon Co., Inc.: Dr. M. H. Bigelow, H. W. DeVore, James L. Rodgers, Jr., Whiting N. Shepard, Horton Spitzer, G. Thomas Walker, Jr.; Plastics, Inc.: George J. Crosman, Jr.; Plastic Products, Inc.: Emil Hemming; Recto Molded Products, Inc.: N. A. Backscheider, Frank Harvey, Irwin H. Klein; Reilly Tar & Chemical Corp.: Wm. J. Dunnican; Richardson Co.: Paul C. Tietz; Röhm & Haas Co.: K. N. Atwater, D. S. Plume; Society of the Plastics Industry: George H. Sicard; Tennessee Eastman Corp.: S. E. Palmer, W. P. Searles; Terkelsen Machine Co.: Harold A. Myers, E. A. Terkelsen.

The beautiful location of the Homestead Hotel in the Blue Ridge Mountains also attracted as guests: Mrs. K. N. Atwater, Mrs. C. A. Breskin, Mrs. Howard Bunn, Mrs. George Crosman, Mrs. William T. Cruse, Mrs. Donald Dew, Mrs. C. W. Douglas, Mrs. E. F. Lougee, Mrs. M. M. Makeever, Mrs. James R. Neal, Mrs. D. S. Plume and Mrs. W. R. Porter.

Permanence of physical properties of plastics

(*Continued from page 52*)

As a solution to Equation [5], we have the following expression for V, which is the rate of plastic deformation with time

$$V = \frac{S}{R}(1 - e^{-Rt/M}) \quad \ldots\ldots\ldots\ldots [7]$$

When t becomes very large, V is equal to the cold flow

$$V = S/R \quad \ldots\ldots\ldots\ldots\ldots [8]$$

Integrating Equation [7], we obtain an expression for the plastic deformation as a function of time

$$y = \frac{St}{R} + \frac{SM}{R^2}(1 + e^{-Rt/M}) \quad \ldots\ldots\ldots [9]$$

From the general solution for plastic deformation as a function of time at constant temperature, it is possible to make the necessary corrections in the calculations of beam deflections. This may be done by assuming that this time-deformation function determines the apparent instantaneous value of the modulus of elasticity. Further, for each material there will be a characteristic coefficient of viscous impedance, M, and a coefficient of internal resistance R. These coefficients will be largely determined by the structural characteristics of the molecules, such as the degree of polymerization; method of polymerization; whether a linear or three-dimensional polymer is present; presence of plasticizing agents; influence of fillers; etc. For further discussion on factors influencing flow characteristics of plastics, there are several papers which may be consulted.[18,19,20] The coefficients mentioned may be calculated from a time-deformation curve at a stress below the elastic limit of the elastic portion of the structure under consideration.

The question would naturally arise, in view of the creep and cold-flow characteristics of the plastics, as to what interpretation should be given to the modulus of elasticity. Strictly speaking, it would be made a func-

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tion of stress, strain, temperature, and time, inasmuch as the exact location of the elastic limit is open to some question. In the bending of beams beyond the proportional limit, Timoshenko has proposed in the well-known formula $M = EI/p$, that E be replaced by E_r, a variable modulus of elasticity to be determined from measurements of the stress-strain relationships in a step-by-step method.[21]

In spite of the dual nature of the strain characteristics of the plastic materials, whereby one portion of the molecular structure exhibits true elastic deformation, and the other portion is susceptible to plastic deformation even at the smallest stresses (these effects are evenly distributed throughout the structure), we can with justification employ the straight-line portion of the stress-strain relationship to determine the modulus of elasticity under certain circumstances. These conditions demand a short-time loading of the material, and the existence of an elastic deformation considerably in excess of plastic deformation (which was true for most of the materials tested). On the other hand, when time or permanency is a factor, modifications must be made in accordance with the general relationship established for plastic deformation, which is also verified by experimental results of this paper. The necessity for altering the values of the moduli of elasticity has been recognized by other investigators, one proposing a high initial modulus of elasticity for amorphous materials and a low modulus of elasticity after plastic deformation.[22] Better yet, the time dependence of the modulus of elasticity should be determined,[23] a sentiment in which the author concurs.

Relaxation. The next point to consider is the relaxation upon removal of stress. If the molecular structure were such that elastic phenomena and plastic phenomena operated independently of one another, a rapid elastic recovery would ensue with no further recovery. However, such a condition does not exist and the energy for the plastic recovery (sometimes referred to as the *elastic aftereffect*) is derived from a portion of the elastic structure. The rate of recovery will still depend upon a coefficient of viscous impedance and a coefficient of internal friction, both cooperating to make the rate an exponential function of time. This observation has been made by other investigators.[4,24] Further, when a constant deformation is maintained under loading conditions, we may expect an exponential recovery of stress. Steinberger observed this condition for some cellulose esters, expressing the recovery of stress in an exponential equation.[11]

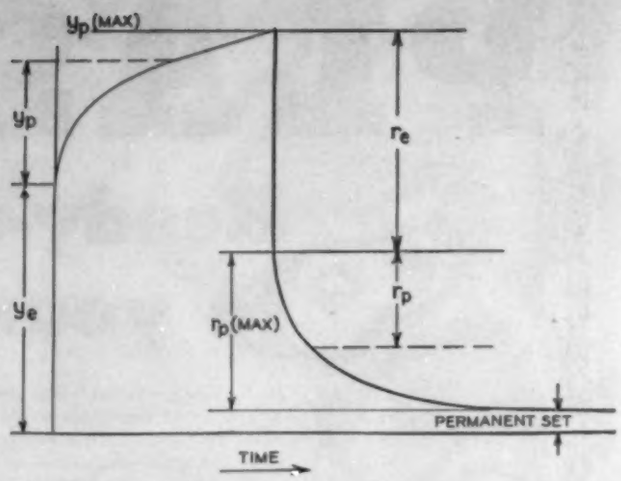

Fig. 4—Typical time-deformation characteristic

It will also be observed that the recovery from deformation will not be 100 percent, due to a permanent set which occurs as a result of the loss of stored energy from the elastic structure. Likewise when the stress is great enough to exceed the proportional limit of the elastic structure, the permanent set is very much greater. Thus the permanent set in the material will be a function of the time of stress application, temperature, and the amount of stress to which the material has been subjected. This behavior has been corroborated by the results of this investigation. Houwink also points out the influence of thermorecovery upon permanent set, wherein a further recovery from deformation ensues when the material is placed at a temperature higher than that at which it was deformed.[4]

If we admit the existence of a true elastic portion of the molecule, how then are we to determine correctly its true elastic limit if the results for the whole structure are susceptible to plastic influences even at low stresses? Grouping the deformation and recovery phenomena, there is the following:

Elastic deformation (y_e) + plastic deformation (y_p) = elastic recovery (r_e) + plastic recovery (r_p) + permanent set

If upon the removal of the load, $r_{p\max}$ exceeds $y_{p\max}$ we have then exceeded the true elastic limit of the material, for it is only through a nonelastic deformation of the true elastic structure, resulting in a retardation of the elastic recovery, that this condition would be true (Fig. 4). Thus the true elastic limit of amorphous materials may be defined as follows: When stress is applied such that the elastic deformation y_e exceeds the elastic recovery r_e the applied stress exceeds the elastic limit of the material. This definition is true regardless of how long the stress is applied though the longer the stress is applied the greater is the difference. For example under the conditions of the test, the following results (next page) were noted for polyvinyl chloride acetate and methyl methacrylate. Elastic recovery

18. Colloid Developments in Synthetic Resins, by H. L. Bender, H. F. Wakefield, and H. A. Hoffman, Chemical Reviews, *15*, 1934, pp. 123–137.

19. Measurements of Flow Characteristics of Plastics, by H. L. Bender, H. F. Wakefield, and H. E. Riley, Symposium on Consistency of the American Society for Testing Materials Meeting of June 29, 1937, Philadelphia, published by the Society, 1938, pp. 64–70.

20. Plastics in Engineering, by J. Delmonte, Penton Publishing Company, Cleveland, Ohio.

21. Theory of Elastic Stability, by S. Timoshenko, McGraw-Hill Book Company, Inc., New York, N. Y., 1936.

22. Elasticity of Amorphous Bodies, by P. Kobeko, E. Kuvshinskij, and G. Gurevich, Technical Physics, U.S.S.R., *4*, 1937, pp. 622–637.

23. Relations Between Viscosity and Elastic Properties of Amorphous Substances, by W. Kuhn, Zeitschrift für Physikalische Chemie, *42*, 1939, Abt. B-1, pp. 1–38.

24. Researches on Rubber and Rubber-Like Substances, by K. H. Meyer, Chemistry and Industry, *57*, May 7, 1938, pp. 439–445.

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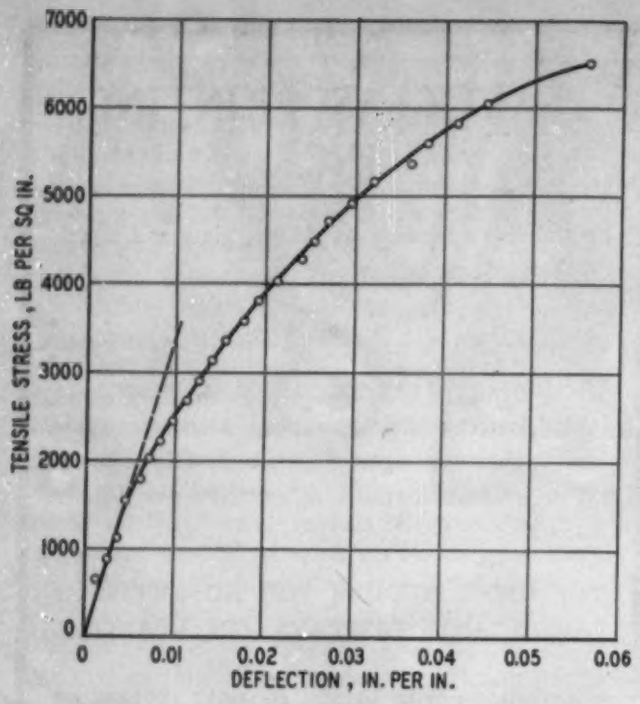

Fig. 5—Stress-strain curve for methyl methacrylate

for each material was determined after 50 hrs. and 100 hrs. of applied stress, respectively.

	Ratio of y_e/r_e	
Max. fiber stress, lbs. per sq. in.	Polyvinyl chloride acetate	Methyl methacrylate
500	1.00	1.06
1000	1.00	1.06
2000	1.01	1.20
3000	1.90	1.64

Similar relationships of y_e and r_e were observed for all of the other materials. Thus in applying the definition of elastic limit given in the preceding paragraph, when y_e begins to exceed r_e at an increasing rate, the elastic limit of the material is exceeded. The longer the stress is applied, the greater will be this distinction, enabling the observer to readily determine the elastic limit of the elastic portion of the molecule. From this tabulation, we find that the elastic limit of polyvinyl chloride acetate lies between 2000 and 3000, and the elastic limit of methyl methacrylate lies between 1000 and 2000 lb. per sq. in. To check this result very careful measurements were made of the direct-tension stress-strain relationships of methyl methacrylate (see Fig. 5), and from these data the elastic limit between 1000 and 2000 lb. per sq. in. was verified.

Temperature. No results were available at the time of preparing this paper on the characteristics of the materials at different temperatures. Aside from the phenomenon of thermorecovery, already mentioned, also of note are the observations of Hetényi, who pointed out that at temperatures of 110 deg. C., the phenol-aldehydic plastics behaved as true elastic materials. He emphasized also that the speed of deformation is greatly dependent upon the temperature.[25] These observations were conducted on test beams supported at two points and under a given stress for a period of 5 hrs. The true elastic behavior of plastics at high temperatures was also noted by Houwink.[26] Other results on the temperature dependence of plastic deformation are also enlightening.[27,11c]

The concluding part of this paper to be published in the June issue will present experimental data regarding plastic deformation and other permanence properties of plastics.

25. The Fundamentals of Three-Dimensional Photoelasticity, by M. Hetényi, Trans. A.S.M.E., *60*, 1938, pp. A-149 to A-155.

26. Elasticity of Amorphous Materials in Relation to Their Internal Structure, by R. Houwink, Trans. Faraday Society, *32*, January, 1936, pp. 122–131.

27. Temperature Dependence of Plasticity, by H. Ekstein, Zeitschrift für Kristallographie, *92*, December, 1935, pp. 253–274.

Plastics at the A.C.S. Meeting

(Continued from page 53)

ELASTIC AND PLASTIC BEHAVIOR OF LONG-CHAIN SUBSTANCES. H. Mark. Up to a polymerization degree of about 50, plastics behave as powderous substances and do not exhibit any film or fiber building properties. A saturation value of tenacity is reached in the region of a polymerization degree of 250. In the intermediate zone between these two points, the strength of a film or filament produced from these substances increases proportionally with the chain length. Elasticity and plasticity of a material depend considerably on the ratio between crystallized and amorphous fractions. If the former prevails, the sample is stiff, hard, and unelastic (overstretched cellulose films or filaments); if the amorphous fraction predominates, the materials are soft and highly elastic (rubber, cellulose acetate, etc.).

PLASTICIZERS FOR CELLULOSE ACETATE AND CELLULOSE ACETATE BUTYRATE. C. R. Fordyce and L. W. A. Meyer. The physical characteristics of 40 plasticizers have been investigated to supply suitable data for evaluation of plasticized compositions for different uses. Estimated values of maximum permanent compatibility have been determined from accelerated retention curves. Cellulose acetate butyrates offer increased compatibility with plasticizers of outstanding water resistance and retention characteristics. A mixed ester of 35 to 40 percent butyral content is especially suited for molding compositions of adequate flow with low plasticizer concentrations and of improved weathering qualities as compared to cellulose acetate plastics.

VISCOSITY AND PROPERTIES OF HIGH MOLECULAR WEIGHT SUBSTANCES IN SOLUTION. R. Simha. Results of studies of high molecular weight substances in solution are compared with data obtained on model suspensions, such as glass spheres, fungal spores, and stiff and soft silk rods. Measurements of internal friction and the direction of further investigations are briefly discussed.

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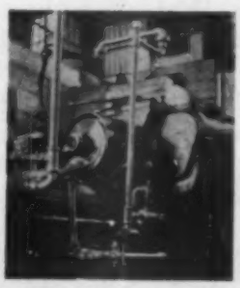

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South American plastics trade

(*Continued from page 43*) United States and certain European countries. Attractive catalogs, literature in Spanish, offers of technical advice, and other such inducements would all contribute toward increasing and maintaining the share of American trade in this market, but far more important than any of these considerations is the necessity for competitive prices and credit terms.

Exchange control

Another outstanding factor which has restricted American participation has been the Argentine system of exchange control, which favors those countries with which Argentina has a favorable trade balance or with which it has negotiated trade agreements. Up until recently it was possible for most European merchandise to come in at a favorable exchange rate, whereas a large part of imports from the United States had to pay an extra differential which raised the landed cost of American goods by 20 percent. This was subsequently changed so that the same rate of exchange applied to a given class of imports regardless of origin, but it was supplemented by a quota system which restricts the importation of certain merchandise from specific countries.

During the first part of 1939, for instance, exchange permits were denied on plastic materials from the United States; later in the year an 80 percent quota of previous imports was established; and still later, when it became apparent that there might be difficulty in getting supplies from Europe, American plastic materials could be imported without restriction. Needless to say, this varying and unpredictable treatment, or the uncertainty of obtaining exchange permits for future imports from the United States, is not conducive to steady patronage on the part of local consumers.

Trade lists

The Commercial Intelligence Division has prepared a list covering the plastics industry, which includes names of firms using various types of plastics, as well as importers and dealers in plastic materials. The prescribed fee for this list is one dollar ($1.00).

Plastic molding machinery

Most of the machines in local use are for compression molding of thermosetting plastics. As stated previously, a full line of thermosetting plastic articles are produced in Argentina, and it is difficult to specify the size of articles manufactured. However, the items range all the way from the smallest buttons or bottle caps to guitars.

Owing to the small activity in thermoplastic production, there are reported to be only 3 or 4 injection-molding machines in Argentina.

Many of the compression-molding machines in domestic use could not be classified as modern, and some of the presses are hand-operated. A number of these hand presses were made in the country. There are no local firms specializing in the manufacture of plastic-molding machinery, as the comparatively simple types made locally can be built in any large machine shop; in fact, some of the Buenos Aires' plastic-molding firms have built their own machines.

The larger imported machines have come mainly from Germany, because of low prices, and to a lesser extent from the United Kingdom. American machines, in addition to being more expensive, are generally offered in much larger sizes than can be profitably used locally, and for this reason only a few of them have been imported.

Making croquet tough

(*Continued from page 34*) pieces is applied by a patented dipping process developed by Plastic Design & Sales Corp. after nearly two years of experimentation. This company does none of the actual work but simply licenses manufacturers who wish to make use of the process. Bright Plastics, Inc., a licensee, is using the pyroxylin coating on other things besides croquet sets. Shoe trees and luggage handles, for instance, are injection molded of a new asphalt base plastic and finished with a coating of plastic color. While the asphalt plastic is inclined to be somewhat brittle, the pyroxylin coating serves to make the completed pieces strong and durable besides glorifying them with becoming colors. The pieces cure within 20 minutes from the time they are dipped, with a plastic coating as high as $^1/_8$ inch.

Because of the low material cost, this molding-dunking method of production is most economical, particularly for large shapes. For really small items, the relatively high labor cost overshadows any saving in material cost. There are other definite limitations in the coating process, too. Some of the things that can't be done are intricate designs, irregular shapes, or anything with an angle or sharp corner. On the other hand, regular shapes and fairly large pieces respond beautifully to the treatment. One noteworthy development on the way has to do with inexpensive radio cabinets. According to present indications, these will be injection molded two at a time of asphalt plastic, and then will be given a colorful, wearable coating by dipping in a pyroxylin solution.

The dipping process has been available only since last September but already four companies have been licensed to do the work and many more are seriously considering its possibilities.

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